The American Journal of Surgery

NEW SERIES, VOL. XXIII FEBRUARY, 1934 No. 2

EXPERIENCES WITH A NEW MODE OF TREATING

PEPTIC ULCER

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SEVERAL years ago attention was called to a method of treating peptic ulcer by a combination of lipoproteins with emetine. The use of non-specific proteins in the treatment of gastric and duodenal ulcer is not new. Experiments with these substances have shown that they exert a definite action on gastric and intestinal motility. According to Mueller and Petersen, this effect is manifested by a decrease in gastric peristalsis. Others, notably Pribram and Holler, observed an arrest of pylorospasm. There is also experimental evidence that the injection of foreign proteins produces a hyperemia of the gastric mucosa which tends to promote healing of the local lesion. Whether non-specific proteins have an influence upon the acidity of the gastric juice has not been definitely established. Clinically, the use of lipoproteins in place of proteins has been found advantageous because their action, while similar, is not attended with a shock reaction.

The effect of emetine on the gastrointestinal tract has been studied pharmacologically and clinically. It has been demonstrated that this drug is excreted slowly and almost completely by way of the intestinal mucosa. It relaxes smooth muscle and thus reduces pyloric spasm. It has also been contended that emetine acts beneficially because of its antibacterial properties. This view is favored by those who consider peptic ulcer an infective process. Its destructive action upon pathogenic organisms is probably not direct but due to a change in the acid-base equilibrium of the tissues, thus inhibiting bacterial growth. In this respect emetine supplements the action of the lipoproteins which increase the natural resistance powers to infection.

In ulcer cases in which immediate surgical indications do not exist, it is becoming increasingly difficult to obtain that complete medical cooperation so necessary for a satisfactory regime. A large number of patients have had one or more courses of the Sippy treatment or some modification over a period of years with more or less unsatisfactory results. They still have their symptoms and they still have their ulcers, but they do not wish to be operated upon. More recently some have tried the mucin treatment with variable results. Still others have abandoned all attempts at medication or dietary control and have simply gone on a self-prescribed milk diet with an accompanying relief of pain but with a return of symptoms whenever more substantial food was added to the diet. Moreover, the economic stress of the past few years has placed many ulcer patients in a position where despite repeated failure of medical measures they

are not in a financial position to defray the cost of an operation and are averse to becoming objects of charity. Then there are patients who are prejudiced against operation by acquaintances who have not benefited by surgical treatment. Lastly, there is that type of ulcer patient who lacks sufficient intelligence to follow directions as to diet.

As stated by Pitkin* in his report, the fact that there is such a divergence of opinion as to the treatment of peptic ulcer, especially the choice of the surgical procedure, is evidence that there is much ground for experiment and improvement.

In view of these considerations, further investigation of any agent is justified if in a large percentage of cases it can be shown to give symptomatic relief, at the same time allowing the patient to continue his everyday routine. Moreover, if there is definite evidence that the new method promotes healing of the ulcer it is certainly deserving of further use.

This report deals with a series of patients who were treated with a combination of lipoproteins and emetine, known as synodal. The series can be divided into two groups: First, 29 cases in which treatment was completed more than a year ago. Each case was checked every three months for one to two years. Second, 22 cases treated during the past twelve months which are being checked every three months but in which varying periods of less than one year have elapsed since completion of treatment.

GROUP I

	Females	Males
Gastric ulcers	3	3
Duodenal ulcers	6	14
Total	9	17
Gastrojejunal ulcer (following post-gastroenterostomy for duodenal ulcer)	..	2
Combined gastric and duodenal ulcer	..	1

* Pitkin, G. P. A new treatment of peptic ulcer. AMER. J. SURG., n.s. 12: 466, 1931

Of the gastric ulcers all except one were situated on the lesser curvature of the stomach and from 1 to 3 inches from the pylorus. Four were of the deeply penetrating type.

Of the duodenal ulcers only one was of the penetrating type as far as we were able to demonstrate by *x*-ray and fluoroscopy.

Eight patients were between twenty and thirty years of age; 7 between thirty and forty; 4 between forty and fifty; 4 between fifty and sixty; and 6 over sixty years of age.

GROUP II

	Females	Males
Gastric ulcers	2	4
Duodenal ulcers	5	10
Total	7	14
Gastrojejunal ulcers	..	1

Six patients were between twenty and thirty years of age; 3 between thirty and forty; 4 between forty and fifty; 7 between fifty and sixty; and 2 over sixty years of age.

In the combined series, 3 patients had been previously operated upon for duodenal ulcer and in each a posterior gastroenterostomy had been done.

All of the patients in both groups were subjected to a complete routine examination in order that any factors which might tend to obscure the diagnosis might be eliminated. Only those patients were treated with synodal in whom the clinical and roentgenological evidence pointed without question to the presence of an ulcer.

The routine carried out was as follows:

1. Complete history.
2. Complete physical examination.
3. Elimination of all foci of infection, such as of the teeth and sinuses or in the genitourinary tract.
4. Laboratory examinations of the blood and urine, gastric analysis, and stool examination.

5. Duodenal drainage in certain cases of duodenal ulcer, merely as a matter of study.

6. Complete gastrointestinal *x*-ray examination, including gall-bladder visualization and barium enema.

7. Rectoscopy, sigmoidoscopy, if indicated.

Although of only passing interest, the family history of the occurrence of ulcer was instructive. In 6 cases of Group 1 one of the parents had probably suffered from an ulcer. In 8 cases a brother or sister had had a condition which was diagnosed as ulcer. In 3 cases a parent had died of carcinoma of the stomach, and in 1 case a brother had died from the same disease.

Symptoms: In the combined groups all but 4 patients stated that pain was their most prominent symptom and that relief from it was what they most desired.

Relief of Pain: Six patients, all men, relieved the pain by drinking coffee and resorted to this about every two or three hours. One, a taxi driver, estimated that he drank 15 to 18 cups of coffee daily. In 4 of the gastric ulcer cases relief was obtained only by vomiting or emptying the stomach; in others by partaking of food, drinking milk or alkalies. Many patients found that sodium bicarbonate did not give constant relief and that even after large doses the result was uncertain.

Vomiting: Nausea and vomiting were complained of by few. This symptom was more prominent in gastric than duodenal ulcer cases.

Hematemesis: In 2 cases hemorrhage was massive and the first symptom of the ulcer.

Gastric Analyses: No unusual information was obtained by gastric analyses, except in one case of gastric ulcer. In this case no free HCl could be obtained in the specimens, even after histamine injection. Four months after treatment the gastric analyses showed: Free HCl 3; combined acidity 14; total acidity 17. In 3 cases of Group 1, where the free HCl was from 60 to 65 prior to treatment, one year later it was from 20 to 30. Eight cases of duodenal ulcer showed a free HCl of between 20 to 30 prior to treatment and about the same one year later. In 2 cases in which a hypoacidity was present before treatment (free HCl 3 to 8) there was a relatively normal free HCl (20 to 28) one year after treatment. Fourteen cases showed gross blood in the gastric contents which could hardly be attributed to trauma and in 10 cases occult blood was present. In none of the 14 cases was there any blood present one year later.

Blood Examinations: Seven cases in Groups 1 and 11 showed a marked secondary anemia with a hemoglobin of less than 60 per cent (Sahli) and a red blood count below three million. All of these cases returned to normal during treatment. All were positive for blood in stools and 6 were positive for blood in gastric contents.

Examination of Stools for Occult Blood:

		Positive	
		Cases	Per Cent
Group 1	Gastric ulcers	6	100
	Duodenal ulcers	11	55
Group 11	Gastric ulcers	2	33.3
	Duodenal ulcers	2	13.3

Treatment: Each patient was given 1 ampule of synodal solution intravenously every fourth day for 10 doses. A fine gauge needle was employed. The usual time of administration was about three or four hours after the noon meal in order to avoid the possibility of vomiting, due to relaxation of the cardia. The injection was made with the patient in the prone position and this was maintained for five minutes because of the complaint of slight dizziness in a few cases. In no case was any reaction seen but should it occur I would be inclined to give adrenalin. A physician who received a number of ampules for trial stated that following the fifth injection his patient developed muscle soreness in the arms and legs. Not much importance was

attached to this symptom but it became more marked following the sixth injection so that further treatment was discontinued. In none of my cases was there need of a second series of injections.

Smoking, coffee, tea and alcoholic beverages were prohibited during the course of treatment.

Diet: For the first ten days a bland smooth diet consisting of soft-boiled eggs, toast with butter, clear bouillon, consomme, a pureed vegetable, custard, and six glasses of milk daily was given. After ten days fruit, cereal with cream, chicken, and lamb chops were added to the diet.

At the end of four weeks patients were allowed to resume their normal daily dietary routine.

Except for 3 patients who were markedly anemic and were kept in bed for two weeks, all were ambulatory and able to follow their occupations.

As a laxative, mineral oil, or a mineral oil and agar preparation was advised.

Results: In all except 2 cases complete relief from pain occurred promptly. It is regretted that the time of disappearance of pain was not correlated to the number of the injection given. However, the statement can be made that all of the benefited patients volunteered the information that they were free from pain shortly after the beginning of treatment.

In the 2 cases not benefited pain was still present and gastric distress was about the same as before treatment. One of these patients had a gastrojejunal ulcer following gastroenterostomy. Following operation he had had lobar pneumonia and since then had been harassed by marital and financial troubles and had attempted suicide several times. In view of his past postoperative experience almost anything seemed better than another operation.

The other failure occurred in a case of simple, uncomplicated duodenal ulcer of apparently eight months' duration in a man thirty-eight years old. There was nothing in the history to explain the lack of improvement. The roentgenograms of the ulcer taken after completion of treatment were similar to those made before, and the gastric chemistry was the same. Later the patient was put on the Sippy regime without success.

Four of the patients in Group 1 have gradually resumed their former excessive use of alcohol without any return of symptoms.

Each patient was carefully fluoroscoped once a week and roentgenograms made one month after completion of treatment. This was followed by a fluoroscopic examination once a month for a year, after which roentgenograms were again made. Some of the most striking are illustrated here.

The weight of all patients was checked weekly. All of the patients gained weight, the average gain being 8 lb. (minimum 2 lb., maximum 35 lb.) during the period covering the ten injections of synodal.

Four patients with a positive Wassermann reaction subsequently received antisyphilitic treatment.

The criteria used to determine healing of the ulcer were:

1. Absence of all clinical symptoms, pain, bleeding, epigastric distress, burning, eructations, etc.
2. Roentgenological findings showing the changes in the ulcer (see illustrations).
3. Gastric analyses: Definite change in the gastric acidity.

In several cases in which a gastric ulcer was present on the greater curvature, the question of carcinoma or malignant degeneration of the ulcer was considered. Clinical tests and fluoroscopic examinations made once a week showed either complete disappearance of the ulcer niche or definite improvement so that malignancy could be ruled out.

CASE REPORTS

Case 1. *Gastric Ulcer.* Mrs. M., aged sixty-three, housewife, married. July 14, 1931.

Complaint: Severe epigastric pain for past three months, which is described as a dull burning and which comes on almost immediately after eating. It is not relieved by taking

sodium bicarbonate but is relieved by vomiting, so that in the past month she has forced herself to vomit as soon as the pain became severe. There is also a feeling of heaviness in the epigastrium, distention and marked belching of gas.

Past History: Has had "indigestion" for ten years, consisting mostly of distention, belching of gas, obstinate constipation for which she has constantly used various cathartics and for the past year usually mineral oil. Otherwise, has never been ill since childhood. Has never noticed any dark or tarry stools.

Physical Examination: Except for a widening of the aortic arch and arterial sclerosis with hypertension (systolic 180, diastolic 100), the physical examination was essentially negative.

Weight: 140 lbs., loss of 25 lbs. in one year, 15 in past month.

Laboratory Examination: Blood: W.B.C. 10,000; R.B.C. 3,312,000; Hgb. 55 per cent. Differential smear: polynuclears 77, small lymphocytes 16, large lymphocytes 5, eosinophiles 2. *Wassermann reaction:* Negative, Kolmer, Kahn antigens. *Urine:* Sp. gr. 1,020, albumin 0, sugar 0. Microscopically, no casts seen. *Stool:* Occult blood +++ in 3 specimens.

Gastric Analysis		Free HCl	Comb. Ac.	Total Ac.
	Fasting	0	10	10
	15 min	0	12	12
100 c.c. alcohol 7 per cent	30 min	3	14	17
	1 hour	6	12	18
	1½ hrs	4	10	14
	2 hrs	3	8	11

Cholecystography: Normally functioning gall bladder. No stones seen.

Gastrointestinal Series: See Figure 1.

Course:

July 21, 1931: Weight 140. First synodal injection, given intravenously.

July 25, 1931: Second injection.

July 29, 1931: No pain. Feeling much improved. Bowels moving regularly without catharsis. Third injection.

August 2, 1931: Fourth injection.

August 6, 1931: Feeling excellent. Fluoroscopic check-up: No niche on lesser curvature demonstrated. Fifth injection.

August 10, 1931: Weight 146. No symptoms nor pain at any time. Diet increased. Sixth injection.

August 14, 1931: Seventh injection.

August 18, 1931: Eighth injection.

August 22, 1931: Ninth injection.

August 26, 1931: Weight 151 lbs. No symptoms. Tenth injection.

Oct. 30, 1931: Weight 160 lbs. Able to eat any and all kinds of food without distress. Bowels moving regularly. Feeling better than at any time within the last ten years.

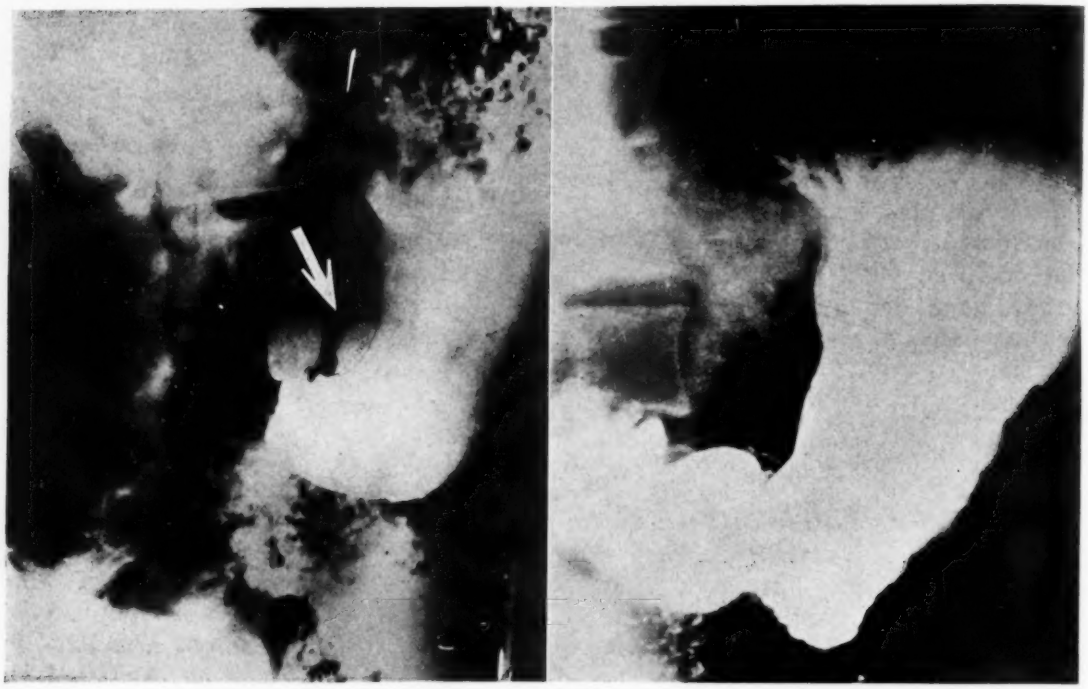
Laboratory Examination: Blood: Hgb. 80 per cent; R.B.C. 4,180,000; W.B.C. 9000. *Stools:* Negative for occult blood.

Gastric Analysis		Free HCl	Comb. Ac.	Total Ac.
	Fasting	0	4	4
100 c.c. 6 per cent sol. alcohol	15 min	0	4	4
	30 min	4	10	14
	1 hour	14	10	24
	1½ hrs	18	14	32
	2 hrs	3	12	15

X-ray of stomach: No evidence of ulcer niche previously demonstrated on lesser curvature. (Fig. 2.)

July, 1932: *One Year Check-up:* Occasionally bowels do not move regularly. Some belching of gas. Weight 165 lbs. *Blood:* Hgb. 80 per cent; R.B.C. 4,020,000; W.B.C. 8200. *Stools:* Negative for occult blood.

Roentgenographic Examination: Stomach normal throughout. No irregularity in outline of lesser or greater curvature. No evidence of ulcer. (Fig. 3.)



FIGS. 1 and 2. Case 1.

CASE II. *Gastric Ulcer.* Mr. D., aged twenty-nine, single, rancher.

Complaint: Abdominal distress, fullness and distention in the abdomen. Dull, dragging sensation not confined to the epigastrium but to the entire upper abdomen, with no direct relation to food intake. No definite pain, no nausea, vomiting or belching of gas. Discomfort not relieved or made worse by taking food. Never has taken soda bicarbonate. Symptoms have been present for fourteen months but there have been frequent periods of several days without discomfort. Has lost 25 lbs. in the past fourteen months and feels very weak. Has never noticed bloody or tarry stools. Bowels have usually been constipated.

Family History: One sister has been under treatment two years for a duodenal ulcer.

Past History: Seven months previously was operated upon for a varicocele to relieve the "dragging feeling."

Previous Treatment: "Sippy regime" (?) at home for four months.

Physical Examination: Essentially negative. Fairly well developed. Weight 122 lb. No tenderness in the epigastrium.

Laboratory Examination: Blood: Hgb. 87 per cent (Sahli); R.B.C. 3,900,000; W.B.C. 6400. Polynuclears 74, small lymphocytes 22, large lymphocytes 4. *Wassermann reaction:* Kolmer and Kahn antigen, negative. *Urine:* Albumin 0, sugar 0, sp. gr. 1.012. Microscopically no casts seen, occ. epithelial cell. *Stool:* Occult blood +++. No parasites or ova.

Gastric Analysis		Free HCl	Comb. Ac.	Total Ac.	
	Fasting..	0	10	10	Gross blood++
100 cc. 5 per cent alcohol	15 min..	8	10	18	Occult blood+++
	30 min..	14	10	24	
	1 hour..	30	12	42	
	1½ hrs..	36	12	48	
	2 hrs....	36	10	46	

Cholecystography: Normally functioning gall bladder. No stones seen.

Gastrointestinal X-ray: There is an ulcer crater on the lesser curvature of the stomach, about 1½ inches from the pylorus. Because of its size and depth it must be closely observed and malignancy ruled out. (Fig. 4.)

Course: Injections of synodal on May 7, 11, 15, 19. After fourth injec-

tion weight, 123½ lb., gain of 1½ lb. Considerable relief, but still has a gnaw-

Fig. 3. Case I.

ing sensation in the upper abdomen.

May 23, 1932: Fifth injection.

May 27, 1932: Sixth injection. Weight, 126, gain of an additional 2½ lb. No symptoms.

Seventh and eighth, ninth and tenth injections on June 2, 6, 10 and 14.

Gastric Analysis: (July, 1933)	Free HCl	Comb. Ac.	Total Ac.
Fasting	11	30	41
15 min	10	13	23
30 min	14	10	24
1 hour	12	26	38
1½ hrs	12	20	32
2 hrs	10	12	22

Weight: 137½ lb.
No symptoms.

July 13, 1932: Weight, 134 lb. No symptoms. *Stool:* Occult blood negative.

X-ray Report: The ulcer crater previously reported on the lesser curvature

Fig. 4. Case II.

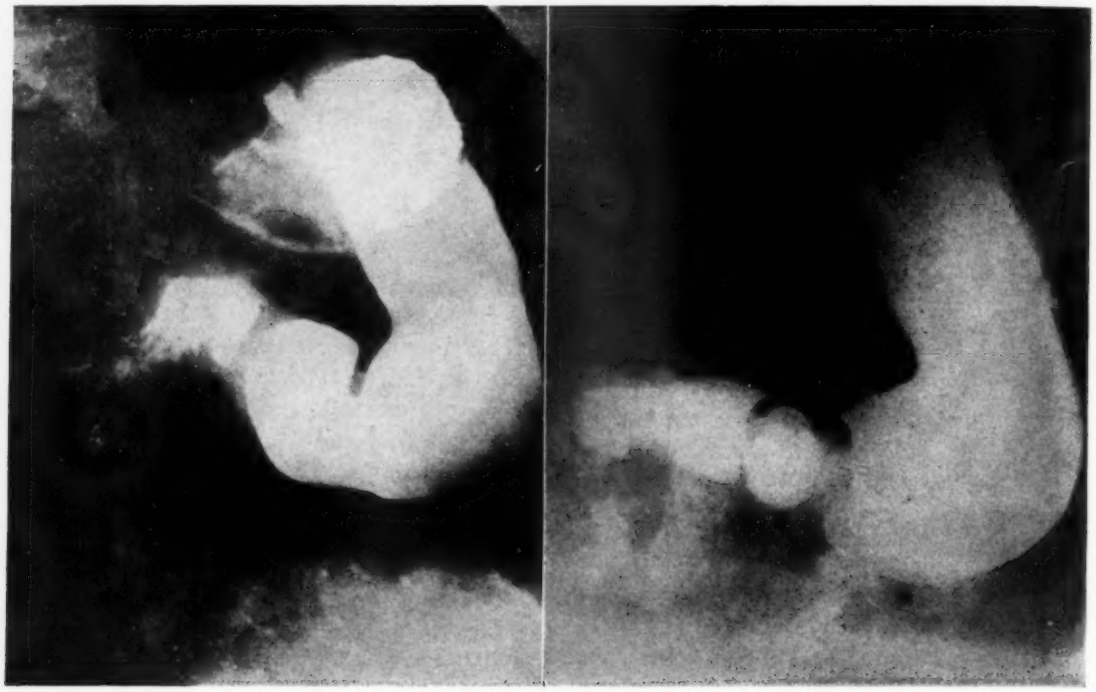
seems to have disappeared entirely. (Figs. 5 and 6.)

July, 1933: There is no irregularity in the outline of the lesser curvature. No evidence of ulcer. Site of previous crater is smooth and normal in contour. For gastric analysis see preceding column.

Case III. *Gastric Ulcer.* Mr. F. G. aged sixty, retired.

Complaint: For past year has had severe pain in epigastrium, coming on about two hours after eating. It is described as a sharp, intense, burning pain which often doubles him up. During the past two months it has been particularly severe. Not relieved by taking food but made worse. Relieved by sodium bicarbonate, of which a considerable amount is taken in the course of a day. Besides constant burning in epigastrium, has a sense of fullness, considerable belching of gas. Frequently vomits after a meal. Vomitus is usually a very acid liquid, never any blood.

Vomiting seems to relieve the pain. Unable to sleep restfully at night because of the burning and pain. Bowels are usually constipated.



Figs. 5 and 6. Case 11.

Has never noticed blood in stools. Has lost 26 lb. in the past twelve months and feels very weak.

Physical Examination: Fairly well developed and nourished, but skin is pale and loose. Conjunctivae and mucous membranes pale. Heart and lungs normal. B.P.: 170/90. Abdomen: Marked tenderness on palpation over the entire upper abdomen but localized particularly in the epigastrium. Definite spasm of the entire musculature of the upper abdomen. Except for large protruding external hemorrhoids and marked leg varicosities, the physical examination is otherwise negative.

Laboratory: Blood: Hgb. 51 per cent; R.B.C. 2,950,000; W.B.C. 7200. Polynuclears 66, small lymphocytes 24, large lymphocytes 6, transitionals 4. *Wassermann reaction:* Negative. *Stool:* Occult blood, 1st negative, 2nd, 3rd and 4th ++++.

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.	
Fasting	22	2	24	Occult
15 min	22	8	30	blood +++
30 min	36	10	46	
45 min	40	16	56	
60 min	56	28	84	
1½ hrs	64	26	90	
2 hrs	70	34	104	

Cholecystography: Normal function. No stones.

Gastrointestinal X-ray: There is a deep ulcer niche on the lesser curvature of the stomach, midway between pylorus and cardia, irregular in outline and of about 2.5 cm. in depth, which because of its characteristics should be investigated further.

Diagnosis: Penetrating ulcer of lesser curvature. (Fig. 7.)

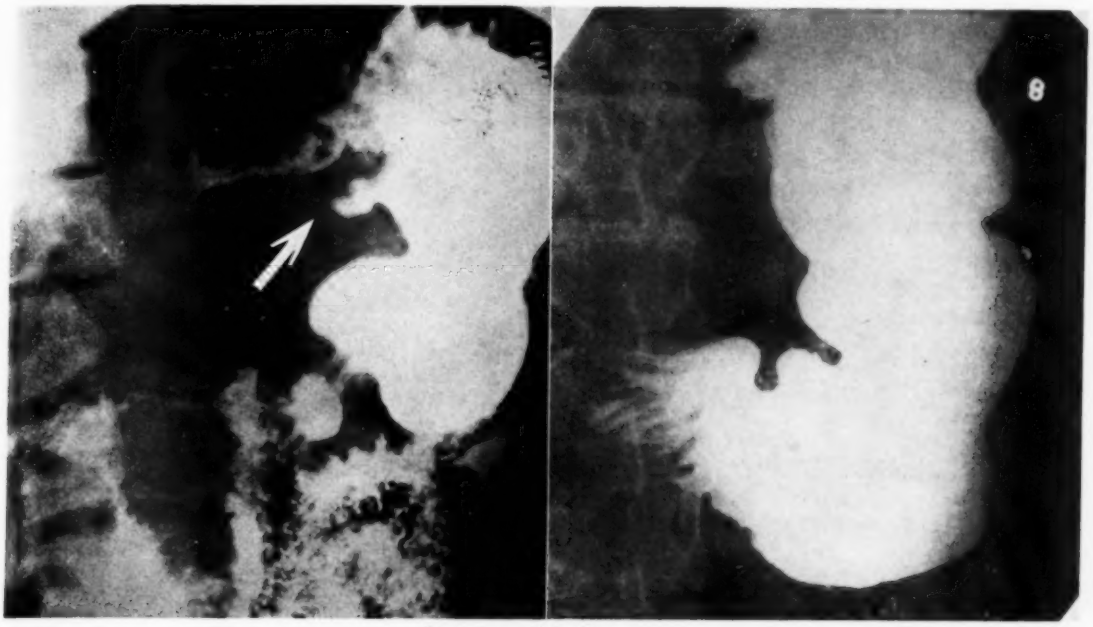
Proctoscopic Examination: Negative, except for marked anemia of the mucous membrane.

Course:

April 1: First injection of synodal.
April 4: Second injection.
April 8: Third injection. Weight 137. No pain. Bowels have been moving regularly, much less gastric distress and eructation.
April 11: Fourth injection.
April 15: Fifth injection.
April 18: Sixth injection. Weight 139. No pain. Bowels regular. Gastric distress, belching and eructations have almost entirely disappeared. Sleeping well and

not awakened by pain or burning any longer.

April 22: Seventh injection. Fluoroscopic examination shows absence of the ulcer niche; outline of lesser curvature is smooth and regular.



Figs. 7 and 8. Case III.

Fig. 9.

April 26: Eighth injection. Weight 141. In spite of a week of very hard work he has had no pain. Bowels have been regular. Occasionally has slight gastric distress.

May 1: Ninth injection.

May 6: Tenth injection. Weight 143. Has had no symptoms whatever.

May 29: Fluoroscopic examination: No evidence of former ulcer niche. Outline of lesser curvature is normal throughout.

July 8: Weight: 149 lb.
X-ray: Outline of lesser curvature is normal throughout. No evidence of former ulcer niche. (Fig. 8.)

August: Weight 151.

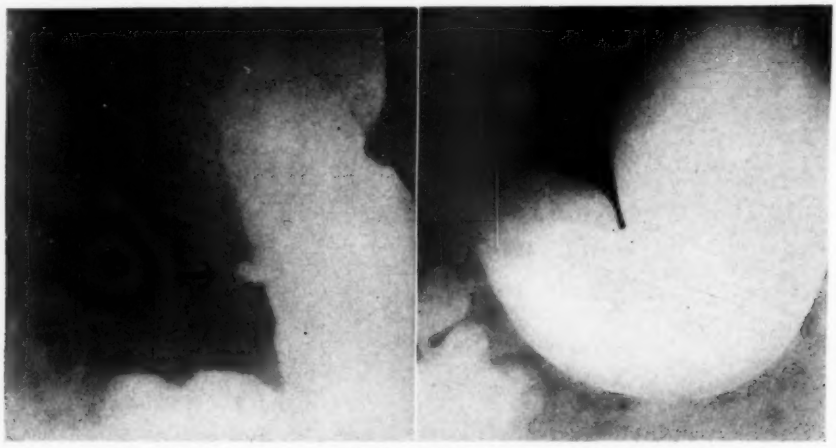
Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.
Fasting	8	18	26
15 min	14	9	23
30 min	11	16	27
1 hour	18	10	28
1½ hrs	16	14	30
2 hrs	14	11	25

This demonstrates a very marked lowering of the acid output in the stomach fol-

lowing administration of the synodal.

Feb. 1933: Stomach normal in outline. No evidence of former ulcer niche.

Physical Examination: Weight 156, a total gain of 22 lb. since treatment was first instituted. There has been no recurrence of symptoms. Epigastrium is normal and former tenderness and localized spasm have disappeared entirely.



FIGS. 10 and 11. Case IV. Note in Figure 11 marked diminution in peristalsis which takes place while under treatment.

CASE IV. *Gastric Ulcer.* Mr. G., aged fifty-two, Italian, laborer.

Complaint: Burning pain in epigastrium coming on immediately after eating, lasting about two or three hours, and relieved when stomach is empty. During past month symptoms have been much aggravated and there was a loss of 13 lb. in this time. Bowels are always constipated. Has had considerable "indigestion" for past two years, consisting chiefly of fullness and bloating after eating, belching of gas, some nausea, and occasionally vomiting. These symptoms have occurred off and on during this period, sometimes disappearing completely for several weeks, but then returning. In the past two months, however, they have been more severe than ever before and characterized particularly by intense, burning pain immediately after taking food, increasing in intensity to a maximum about two hours after eating. Induces vomiting frequently to obtain relief. Sodium bicarbonate and various alkalies have proved of little benefit. Drinks 4 to 6 cups of coffee daily because this seems to quiet the pain. Has not indulged in alcohol in past two years. Smokes 5 to 6 pipefuls of tobacco daily.

Physical Examination: Negative except for very marked tenderness on palpation in the epigastrium.

Laboratory Examination: Blood: Hgb. 70 per cent; R.B.C. 4,192,000; W.B.C. 6400. *Wassermann reaction:* Negative. *Stool:* Negative for occult blood in three different specimens.

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.
Fasting	30	17	47
15 min	32	21	53
30 min	41	27	68
1 hour	63	34	97
1½ hrs	70	41	111
2 hrs	75	52	127

Note the extremely high acid values.

Cholecystography: Normally functioning gall bladder. No evidence of stone.

Gastrointestinal Series: Small nodular-like niche in lesser curvature of stomach about halfway between pylorus and cardia. Niche smooth in outline and about 1 cm. in depth.

Diagnosis: Penetrating gastric ulcer. (Fig. 10.)

Course:

Apr. 1, 1931: First injection of synodal. Weight 153.
Apr. 4: Second injection.
Apr. 8: Third injection.
Apr. 12: Fourth injection. Weight 157. Pain has disap-

peared. No other symptoms. More liberal diet allowed.

Apr. 16: Fifth injection

Apr. 20: Sixth injection

Apr. 24: Seventh injection. Weight 159. No symptoms.

Apr. 28: Eighth injection.

May 2: Ninth injection.

May 6: Tenth injection. Weight 163. Has returned to hard manual labor without any recurrence of symptoms.

May 16: *X*-ray examination shows complete disappearance of former niche on the lesser curvature. (Fig. 11.)

September: Weight 165. No symptoms.

November, 1932: Eighteen months after treatment. No evidence of former niche, stomach entirely normal. Peristalsis normal. Patient has had no return of symptoms. (Fig. 12.)

Case v. *Duodenal Ulcer.* Mr. B., aged twenty-four, bond salesman, married.

Complaint: For past ten years has had epigastric pain, gnawing in character, coming on about one-half to one hour after eating, accompanied by severe burning in epigastrium and sour eructations. Obtains no relief by taking food or sodium bicarbonate. During this period he has been under constant medical supervision, has had various types of restricted diets, with temporary periods of relief but always a return of symptoms after eating more solid foods. Six years ago a diagnosis of chronic appendicitis was made and appendectomy was done, but no alleviation of symptoms resulted. Five years ago after a complete gastrointestinal *x*-ray examination a diagnosis of duodenal ulcer was made. The tonsils, which were badly infected, were removed at this time. After a strict Sippy regime for four months, the patient felt much better but every return to more solid food was followed by recurrence of symptoms. Has therefore in the past four years adhered rigidly to a milk and semi-solid diet with some relief from pain. No nausea, no vomiting, bowels usually constipated, takes mineral oil almost daily. No abdominal distention. Some belching of gas but mostly eructation of acid material to mouth.

Fig. 12. Case iv.

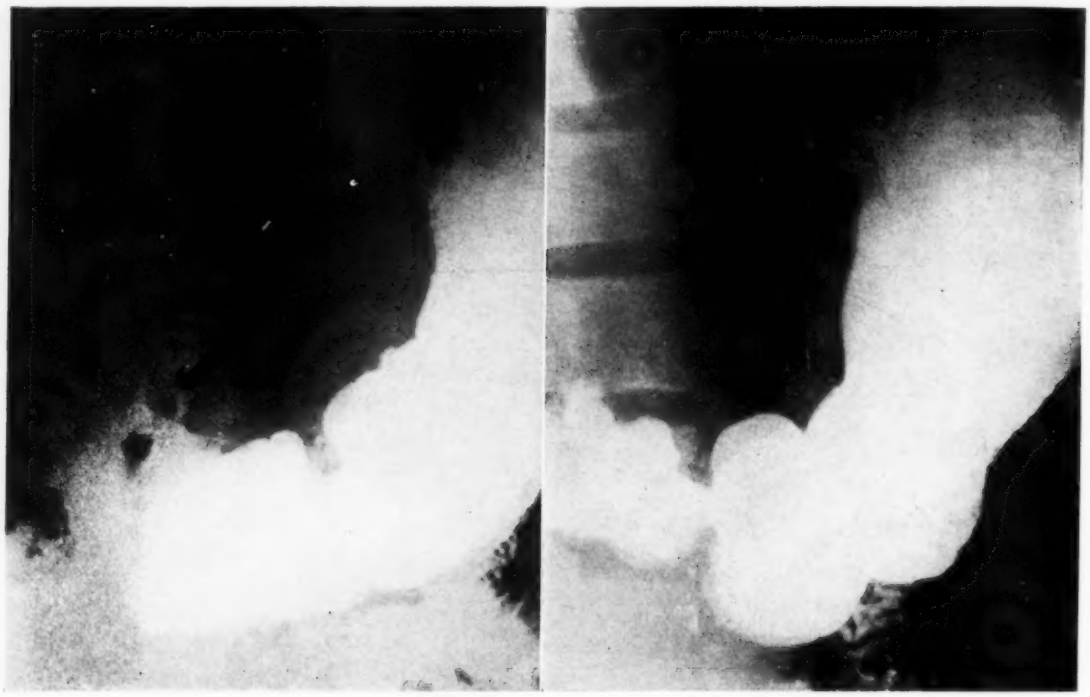
Pbysical Examination: Except for sharply localized tenderness over an area the size of a half dollar, just above and to right of umbilicus, and moderate tenderness on palpation over the cecum, the physical examination is practically negative.

Laboratory Examination: Blood: Hgb. 80 per cent; r.b.c. 4,460,000; w.b.c. 7600. Smear normal. *Wassermann reaction:* Negative. *Stool:* Occult blood +++ in three specimens.

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.
Fasting	22	16	38
15 min	30	24	54
30 min	32	30	62
1 hour	44	36	80
1½ hrs	50	44	94
2 hrs	50	60	110

X-ray: Stomach in normal position. Outline of greater and lesser curvatures shows no abnormality. Peristalsis normal. Duodenal

bulb somewhat contracted, fills readily, but not completely. A defect is seen on the superior border which persists throughout examination and does not change in outline or position.



FIGS. 13 and 14. Case v.

Diagnosis: Duodenal ulcer. (Fig. 13.)

Course:

July 10, 1931: First injection of synodal. Weight 157.
July 14: Second injection.
July 18: Third injection.
July 22: Fourth injection. Weight 160 lbs. No pain. Feels much improved. Stool: Occult blood negative.
July 26: Fifth injection.
July 30: Sixth injection.
Aug. 3: Seventh injection.
Aug. 7: Eighth injection. Weight 161. No burning, no pain. Bowels regular. Occasionally some distention in epigastrium.
Aug. 11: Ninth injection.
Aug. 15: Tenth injection. Weight 164. No symptoms.
Oct.: Weight 170 lbs. No pain or burning in epigastrium, no other distress, but due to fear of recurrence of symptoms he has adhered to a rather restricted diet. (Fig. 14.)

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.
Fasting	8	12	20
15 min	10	12	22
30 min	14	16	30
1 hour	26	12	38
1½ hrs	24	10	34
2 hrs	16	11	27

July, 1932: Weight 175 lbs. No return of symptoms in spite of working long hours and eating irregularly. (Fig. 15.)
Feb., 1933: Weight 174½ lbs. No return of symptoms. Has eaten all types of food but has not smoked nor taken any alcohol since synodal treatment.

CASE VI. *Duodenal Ulcer.* Mr. E. P., aged forty-four, construction engineer, married.

Complaint: Has had "indigestion" for past eight years, consisting of dragging pain in epigastrium, coming on about one hour after eating and lasting about one hour. No nausea or vomiting. Some belching of gas and some

acid eructation. Bowels usually constipated, cathartics of various kinds having been taken almost daily for years. Has never seen any blood in stools. For past six months the pain has been much more severe than formerly. It is dull and boring in character and seems to be relieved by drinking a glass of milk or taking soda bicarbonate. Four years ago a diagnosis of duodenal ulcer was made after *x*-ray investigations and patient was in bed in the hospital for thirty-two days on a Sippy regime. Following this he was on a much restricted diet and alkaline powders for one year with relief of symptoms during this time. As soon as normal diet was resumed pain returned. No loss in weight in the past year.

Physical Examination: Negative except for sharply localized tenderness in epigastrium, midway between ensiform and umbilicus. Weight 161 lbs.

Laboratory: Blood: Hgb. 70 per cent; R.B.C. 4,120,000; W.B.C. 7800. *Wassermann reaction:* Negative. *Stool:* Four specimens, all positive for occult blood.

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.
Fasting	4	7	11
15 min	4	11	15
30 min	15	10	25
45 min	18	15	33
1 hour	30	12	42
1½ hrs	26	16	42
2 hrs	20	15	35

X-ray: Stomach normal. Duodenum shows a contracted bulb which does not at any time fill readily or completely. There is a constant irregularity of the superior border. On the posterior wall near the superior border there is a defect which persists throughout the examination. The duodenum empties very slowly. (Fig. 16.)

Course:

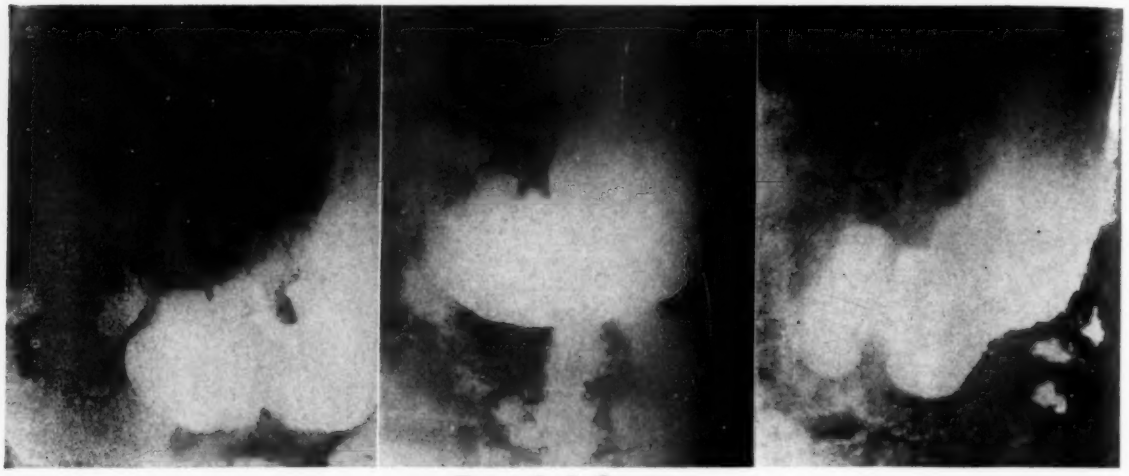
Jan. 1, 1931: First injection of synodal. Weight 161 lbs.
Jan. 6: Second injection.
Jan. 9: Third injection.
Jan. 13: Fourth injection. Weight 162. Has had no pain. No gastric distress. Bowels have been moving regularly.
Jan. 16: Fifth injection.
Jan. 20: Sixth injection.
Jan. 23: Seventh injection
Jan. 27: Eighth injection. Weight 162½ lbs. Has been symptom-free. Stool negative for occult blood.

Fig. 15. Case v.

Jan. 30: Ninth injection.
Feb. 3: Tenth injection. Weight 163 lbs. No pain. No gastric distress. Stool negative for occult blood.
Feb. 10: Weight 164. No symptoms.
May: Stomach normal, no irregularity in outline of greater or lesser curvature. Peristalsis normal. Duodenal bulb fills readily; superior and inferior borders are smooth in outline and no filling defect can be made out. (Fig. 17.)
Jan., 1933: Duodenum normal in outline. Fills readily and empties completely. No outline defect noted. Patient weighs 167 pounds. Has had no further symptoms in spite of working in the mountains and eating at an engineers' construction camp mess

where coarse food poorly prepared has predominated. (Fig. 18.)

relief. Two months ago pain returned but was not relieved by taking alkalies and restricting diet. Noticed that stools were again black.



Figs. 16–18. Case vi.

Case vii. *Pyloric Ulcer.* Mr. G., aged forty-four, stock broker.

Complaint: Stomach trouble began seven years ago during a period of tremendous business and social activity. Went to a sanatorium and was given iron injections, diet and rest, and in eight weeks was able to return to work. Shortly after this, however, began to have a pressure pain in the epigastrium which came on spasmodically but which seemed to be particularly severe when stomach was empty. Found that taking food relieved the pain so that he would drink two or three milk shakes daily. There were no other gastric symptoms. Bowels were usually constipated and he was

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.	
Fasting	20	9	29	
15 min	22	14	36	
30 min	20	19	39	Occult
45 min	18	22	40	blood +++
1 hour	25	21	46	
1½ hrs	23	19	42	
2 hrs	27	17	44	

a constant user of cathartics. The pain continued at intervals up to three years ago, at which time patient noted that stools were black. He consulted a physician. *X*-ray studies were made and he was told that he had a gastric and duodenal ulcer. He was put on a modified Sippy diet and given alkaline powders which he took for eighteen months with

Lost 14 lb. in past thirty days.

Physical Examination: Negative except for badly infected tonsils.

Laboratory Examination: Blood: Hgb. 75 per cent; r.b.c. 4,300,000; w.b.c. 8600. *Wassermann reaction:* Negative. *Differential stain:* Normal. *Stool:* Occult blood +++. For gastric analysis see preceding column.

Roentgenographic Examination: Stomach in normal position. Marked irregularity in outline of lesser curvature at pylorus. This defect has a width of about 4 cm., is deep, with constant irregularity, and peristaltic waves do not pass over this area. In view of the characteristics of the lesion malignancy is suspected. (Fig. 19.)

Course: July 5, 1931: First injection of synodal. Weight 181 lbs.

July 9: Second injection.

July 13: Third injection.

July 18: Fourth injection. Weight 182. Had some pain on one occasion when he took a long drive and did not eat for several hours. Otherwise no pain.

July 22: Fifth injection.

July 26: Sixth injection.

July 29: Seventh injection. Weight 183½. No symptoms. Bowels moving normally. Stool: No occult blood.

Aug. 3: Eighth injection.

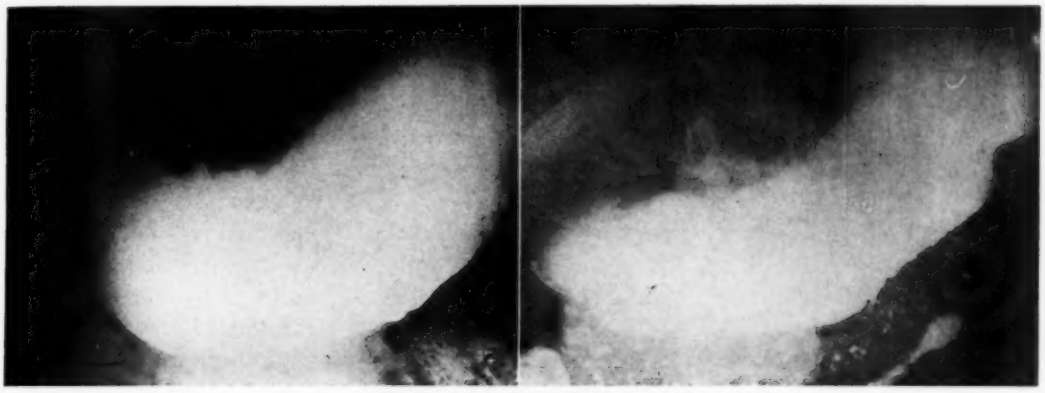
Aug. 6: Ninth injection.

Aug. 10: Tenth injection. Weight 185. Feels excellent. No pain. Bowels moving normally. Sleeps well.

Fluoroscopic Examination: Shows absence of defect noted on previous examination. Peristalsis is normal throughout and is seen to traverse this area. (Fig. 20.)

Jan., 1932: *X-ray Examination:* No evidence of former defect. Outline of lesser curvature normal. Peristalsis normal.

Jan., 1933: Weight 191. No symptoms. *X*-ray examination as in previous report. (Fig. 21.)



Figs. 19 and 20. Case VII.

Case VIII. *Gastrojejunal Ulcer.* Mr. B., aged fifty-five, married, clerk.

Complaint: Symptoms of five years' duration consisting of epigastric pain occurring immediately after eating, deep, burning in character. Pain lasts about two hours and returns after next meal, is not relieved by taking food but is made definitely worse. It is allayed by large doses of alkalies. For three years was on a very restricted diet with alkaline powders, but had periods of alternating pain. Eighteen months ago a Polya resection was done. Was in hospital nine weeks. Had postoperative pneumonia. Four months later was operated on again for a ventral hernia. Operation did not relieve symptoms and during past year condition has become much worse. At present pain is of sharp, stabbing character and is usually accompanied by nausea and vomiting. Some relief is obtained after vomiting. Belches considerable gas, has frequent regurgitation of acid fluid. Bowels are usually constipated.

Past History: Appendectomy 20 years previously. Laparotomy for post-operative adhesions 1 year later. Tonsillectomy 12 years ago. We have been unable to obtain the findings or report of the surgeon who did the Polya resection. The patient states that he was told he had a duodenal ulcer with obstruction. Five years ago he weighed 152 lbs., after operation 18 months ago 135 lbs., now 121 lbs.

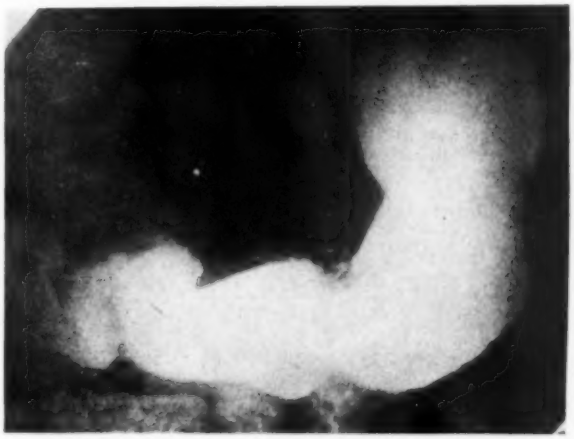


Fig. 21. Case VII.

Physical Examination: Poorly developed, poorly nourished, somewhat emaciated, apprehensive. Marked tenderness over the entire upper abdomen, sharply localized tenderness to left of umbilicus. Scar of old appendix and adhesion operation in right rectus region; midline scar, ensiform to umbilicus, about 5 inches in length. B.P. 100/80.

Laboratory: Blood: Hgb. 75 per cent; R.B.C. 3,950,000; W.B.C. 6,400.

Wassermann: Negative.

Differential stain: Normal.

Stool: Occult blood ++++ − 2 specimens.
Cholecystography: Normally functioning gall bladder. No evidence of stones.

FIG. 22. Evidence in this case was mainly fluoroscopic as fleck of barium was not clearly outlined in *x*-ray plate. This plate was taken after treatment and repeated fluoroscopic examinations failed to reveal former area of barium retention.

Gastric Analysis	Free HCl	Comb. Ac.	Total Ac.
Fasting	0	8	8
15 min	0	11	11
30 min	0	14	14
45 min	0	10	10
1 hour	0	8	8
1½ hrs	0	6	6
2 hrs	0	6	6

Gastrointestinal Series: Position of stomach normal. Marked hyperperistalsis. Column of barium passes directly into jejunum. Stomach empties rapidly. At angle formed by junction of stomach with efferent loop of jejunum there is a small irregularly outlined fleck of barium about size of a bean which persists throughout fluoroscopic examination. Findings consistent with a gastrojejunal ulcer.

Apr. 26, 1932: First injection of synodal. Weight 121 lb.
Apr. 29: Second injection.
May 3: Third injection. Weight 122 lb. Still has some pain, distress not so marked.
May 5: Fourth injection. No pain. Feeling better.
May 9: Fifth injection. Weight 123¾ lb.
May 13: Sixth injection.
May 17: Seventh injection.
May 21: Eighth injection. No pain. Weight 124.
May 25: Ninth injection.
May 29: Tenth injection. No pain. Feels much improved. Weight 125 lb.
Sept., 1932: Weight 125 lb. Occasionally has slight pain but only temporarily. No gastric distress. *Stool:* Occult blood negative. *Fluoroscopic examination:* The area described in the former examinations is entirely negative. The gastrojejunal stoma is functioning normally. Peristalsis normal.
Mar., 1933: Fluoroscopic examination same as previously. Weight 125 lb. Occasionally has slight pain in epigastrium but is mild and occurs only rarely. Has no gastric distress and bowels are moving regularly.

CONCLUSIONS

1. The number of cases reported here is not sufficient on which to base any conclusions. However, it is felt that any agent that will give the clinical results reported here is worthy of further clinical study.

2. A large series of cases studied by different observers in various parts of the country under different environmental conditions would shed considerable light upon this method of treatment.

3. Treatment with synodal permits patients to continue their daily routine and shortens their period of strict dieting. It apparently produces those structural changes, as evidenced by roentgenographic studies, which we associate with healing of the ulcer.

TOTAL AND SUBTOTAL THYROIDECTOMIES

INDICATIONS FOR OPERATION AND TECHNIQUE DEVELOPED FROM A SERIES OF 1900 CASES*

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IN this survey of indications for thyroid surgery the clinical classification of the International Association for the Study of Goiter has been followed. Four main types are designated: the non-toxic diffuse, the toxic diffuse, the non-toxic nodular and the toxic nodular goiter. As these are constant characteristics, such terminology as cystic, adolescent and colloid is descriptive of varieties, not types. The technique of operation discussed is that which has proved the most satisfactory from an experience with 1900 thyroidectomies.

SURGICAL INDICATIONS

Toxicity. Toxic goiters are both nodular and diffuse. The newer classification eliminates the term exophthalmic goiter because of the non-constancy of the exophthalmos, a fact which precludes diagnosis on this symptom alone. As implied, it may be absent, or it may belong to a syndrome from an entirely different source, as for example, brain tumor.

Toxic adenomas, the nodular toxic goiters, are rather prevalent in America. The degree of toxicity, as measured by the basal metabolic rate, is lower than in the diffuse type, but may be many times above normal. Resultant symptoms are often so severe that life is threatened. In long existent adenomas we often find a mixed type, commonly termed Basedow's disease; all the symptoms, including the exophthalmos, may be represented.

Malignancy. Authorities agree that malignancy occurs in at least 2 per cent of all goiters; Dr. Lahey[1] has noted the incidence to be much higher in the nodular type, 6⅔ per cent. It is thus apparent that early operation is advised in all nodular goiters, since a tumorous mass is a potential source of malignancy. Although all lesions of the breast are not malignant, the doctor as well as the patient is always apprehensive until the diagnosis is made. It can not be too strongly emphasized that tumors of the thyroid demand the same attention as new-growths elsewhere. If treatment is instituted early, the high mortality of malignant disease of the thyroid will be greatly lessened.

Pressure. Adenomatous compression of the trachea may cause marked interference with respiration or it may become so great as to obliterate completely the lumen of the trachea. Either condition may necessitate immediate tracheotomy. Hemorrhage into the degenerating center of the adenoma, causing sudden compression of the trachea, may call for emergency operation. Intrathoracic adenomas may seriously interfere with cardiac action or initiate respiratory symptoms from pressure on the bronchi. Compression on the brachial plexus, due to large adenomatous masses in the upper thorax, may be the source of severe neuralgia in the arms; and adenoma against the recurrent laryngeal nerve may bring on an intractable cough.

Thyroiditis. Non-suppurative inflammation of the thyroid so closely simulates malignancy that the basis of differentiation is usually an histologic study. These patients are anemic in appearance; the mass is nodular, indurated and fixed to the surrounding tissue, the chief complaint being a sense of pressure. In severe cases

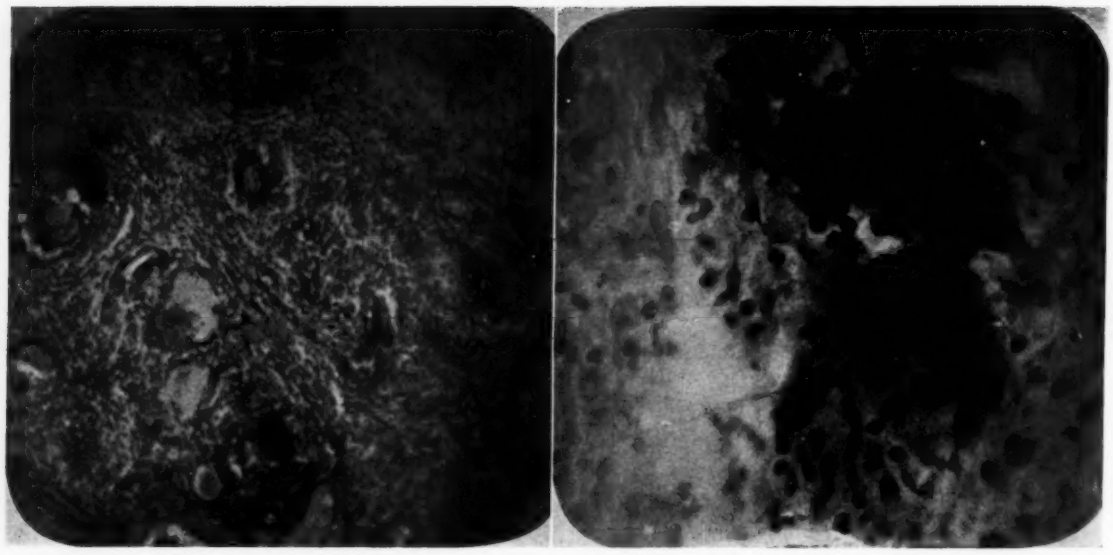
[1] Personal communication.

* Read before the Staff Meeting, Providence Hospital, Feb. 7, and at Harborview Hospital General Staff Meeting, Feb. 8, 1933.

the dyspnea is acute, caused by partial or complete occlusion of the trachea by contraction of the fibrous mass.

of the neck, but dense adhesions and the woody hardness of the tissue often complicate the operation The danger of

A



B C

FIG. 1. Primary tuberculosis of thyroid gland, with complete enucleation of gland. A. Gross photograph of thyroid, tuberculous portion being white area of upper right lobe. B. Photomicrograph of bacilli of tuberculous area. C. Photomicrograph of giant cells.

Operation in these cases is performed to free the trachea from constriction. No more of the gland should be resected than is required to accomplish this end. A wedge-shaped piece of thyroid completely dividing the isthmus allows the lateral portions to retract into the muscles

myxedema warrants the advice to remove only sufficient tissue to relieve the constriction. If the inflammation is the result of some specific infection, such as tuberculosis, the more radical operation may become imperative. Figure 1 depicts such a case; practically all the thyroid was

removed, metabolism kept at level by the use of desiccated thyroid.

Cosmetic. Thyroidectomy may be purely for cosmetic purposes. Large cystic adenomas, although occasioning no constitutional symptoms, present an ugly deformity. In these cases appearance, as well as avoidance of intracystic hemorrhage or possible malignant degeneration, indicates extirpation of the mass.

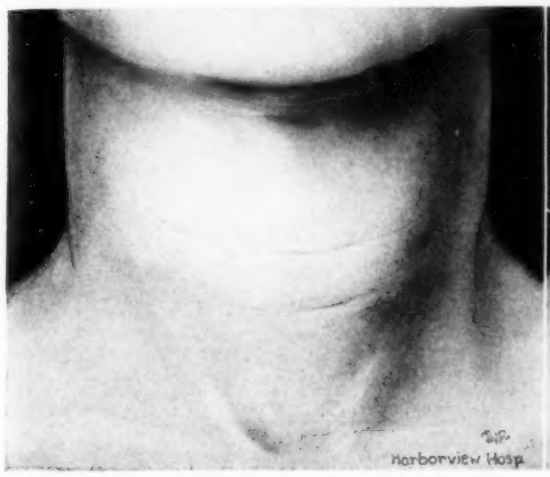


Fig. 2. Natural folds of skin; convexity of incision line.

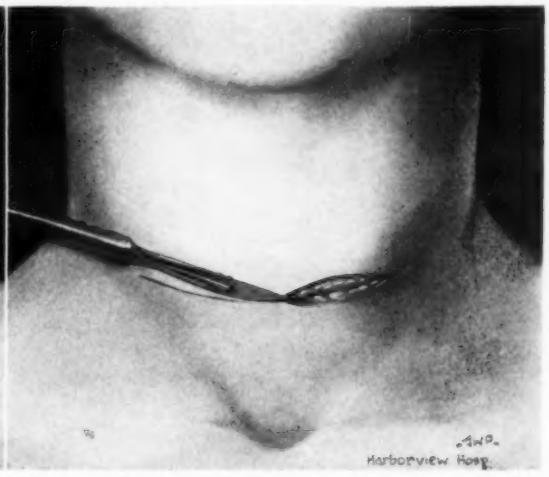


Fig. 3. Depth of incision, cutting through skin and superficial fascia. Fatty layer bulges forth as skin retracts.

Extent of operation is a much mooted question. There is no hard and fast rule by which to estimate what proportion of the gland should be resected. This amount varies from partial, in non-toxic goiters, to complete removal in extensive carcinoma. One lobe may have a well-encapsulated adenoma, readily enucleated, so that the balance of the gland is left intact; but the opposite lobe must be inspected for any remaining adenomata. Severe toxicity indicates removal of the major part of the gland, as relatively small residual portions prevent complete restoration of health. It has been my experience that if portions of the superior poles are left, there is more likelihood of a prolongation of the toxicity. This key portion of the gland, particularly when it extends up behind the trachea, is liable to be overlooked unless the gland is well displaced. A thorough inspection should determine any remaining tissue.

In operating upon toxic cases during pregnancy, more glandular tissue should be left than ordinarily, because of the hypertrophy of the thyroid which is always present during pregnancy. Without due consideration to this condition, we may have such sequelae as hypothyroidism or myxedema at the termination of pregnancy.

Fig. 4. Mode of undermining skin and superficial fascia with gauze.

As a general safeguard, we may say that the content resected is in proportion to the toxicity, or in other words, the function of the specific type. It is evident from the

conditions alluded to, that no rule can be given for resecting any particular fraction of the thyroid. When extensive malignancy has necessitated thyroparathyroidectomy, to my surprise I have found tetany sometimes absent, in other instances mild and transitory in character. The reason for this is not yet understood.

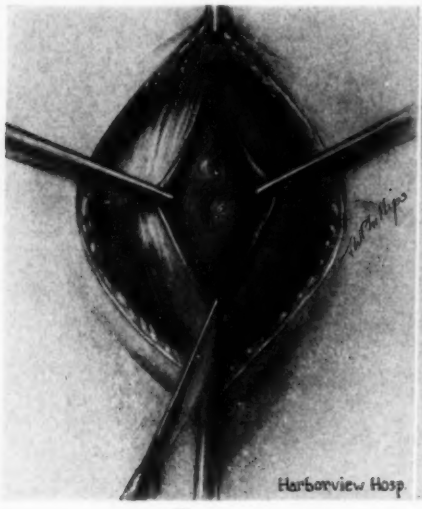


Fig. 5.

Fig. 6.

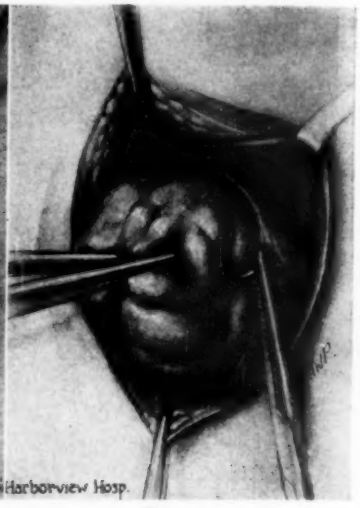


Fig. 7.

Fig. 5. Incision of deep fascia in median line.
Fig. 6. Incision of true capsule of thyroid.
Fig. 7. Picking up middle branch of inferior thyroid vein.

COMPLICATIONS

Hyperthyroid Crises. The former high operative mortality from toxic goiters was due to the intense wave of hyperthyroidism flooding the body with an overload of the poisonous hormone. To Dr. Henry Plummer we owe thanks for the introduction of iodine therapy to neutralize this abnormal secretion. Administration of iodine through the agency of Lugol's solution has almost eliminated the hyperthyroid crisis, formerly the bane of the thyroid surgeon.

Shock. While the degree of shock is in direct ratio to the operative time, it is also in inverse proportion to the skill in handling. Shock is prevented by the utmost care in operative technique and an economy of time consistent with surgical needs. The former implies good team-work. One should never operate upon a severely toxic patient with inexperienced assistants.

Hemorrhage. Uncontrolled hemorrhage may prove rapidly fatal. Unless all bleeding vessels are clamped and carefully tied as encountered, the formation of hematomas will prolong drainage and prevent healing by first intention. A disfiguring scar is the result. Delivery of large substernal masses may tear the inferior thyroid vessels, with consequent hemorrhage so profuse that it is impossible to pick up the bleeding point without injury to the recurrent laryngeal nerve or one of the parathyroids. In this event, pack with 4-inch gauze and complete the enucleation of that lobe; then the packing can be removed and the bleeding vessels easily clamped.

PREOPERATIVE TREATMENT

This regimen may require only a few days or several weeks, depending upon such factors as the patient's reaction to the iodine, plus the condition of the heart, kidneys and respiratory tract. Routine measures comprise partial, or complete rest in bed, a high caloric diet with liberal amounts of carbohydrates, dextrose and

citrus fruits, and the administration of iodine and alkalies. Lugol's solution is given from 10 drops thrice daily up to 30 drops four times a day. If oral administration induces no response, muscular injection of Lugol's solution or the intravenous injection of sodium iodide should prove effective. But when surgical interference is indicated these therapeutic practices are to be condemned, if continued over long periods. Such a case acquires a tolerance for iodine and the toxic symptoms recur. As further iodine has little or no effect, the case again becomes a poor surgical risk.

TECHNIQUE OF OPERATION

The size of the gland is a guide in locating the plane of the incision; obviously the larger the mass, the higher the site. The line must be placed sufficiently high as there is a progressive retraction of the cicatrix downwards. Without due consideration of this fact, the line from very large goiters, after a lapse of several months, will be found 2 or 3 inches below the ideal collar line. As regards the length of the incision, again directions are relative, since large nodular or malignant growths need a much longer incision, so that thorough inspection can conform with adequate speed. The folds of the skin should be followed, or paralleled. As indicated in Figure 2, a slight convexity downward is in line with the natural curves of the neck. A straight line incision should never be made.

Cutting through the skin and superficial fascia (Fig. 3) exposes a layer of fat, of varying thickness up to ¾ inch. A few light strokes of the knife will separate the fatty layer exposing the platysma, which must not be incised. The upper and lower edges of the skin are now retracted. This dissection and reflection of the skin flaps should be extended upward to the larynx, laterally to the posterior border of the sternomastoid muscle, and downward for an inch or inch and a half. It is readily separated to any desired extent with dry sterile gauze (Fig. 4). This undermining of the skin facilitates the later free delivery and resection of the goiter mass. The

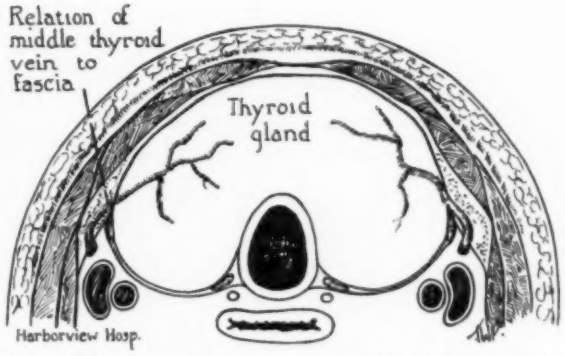


Fig. 8. Diagrammatic cross section showing separation of deep fascia to outer and inner layers and necessity of dividing inferior thyroid vein at this point.

ribbon muscles are next separated medially from the top of the sternum to that of the larynx, cutting through the deep fascia down to the true capsule (Fig. 5). The capsule is then picked up and incised, the thyroid grasped with forceps and delivered (Fig. 6).

Before complete dislocation of the mass, the middle thyroid vein is cut and tied where it leaves the thyroid (Fig. 7). At this point the deep fascia divides into two layers, the outer extending to the carotid sheath, the inner following the thyroid (Fig. 8).

It is seldom necessary for adequate exposure to cut the sterno-thyroid and thyrohyoid muscles transversely. Provided the skin and superficial fascia have been well undermined, delivery of extremely large masses can be effected through the median separation. Exception is made in extensive malignant growths, or in large masses with adhesions from former inflammatory processes, or when one encounters severe hemorrhage. In such instances, the muscles should be severed above the junction of their middle and upper thirds in order to avoid injury to the nerve supply, which enters the muscle below this level.

After the incision of the capsule and the delivery of the mass, the superior poles

should be doubly clamped and cut (Fig. 10). The clamps are left *in situ* until the removal of the desired portion of the gland, otherwise the remaining portion will retract deep into the cervical spaces, greatly increasing surgical difficulties. When ligating superior poles the upper or deeper hemostat is first removed as the ligature is tied; a second ligature is then tied as the remaining clamp is removed.

Fig. 9. Further dislocation of gland, after separation of inferior thyroid vein.

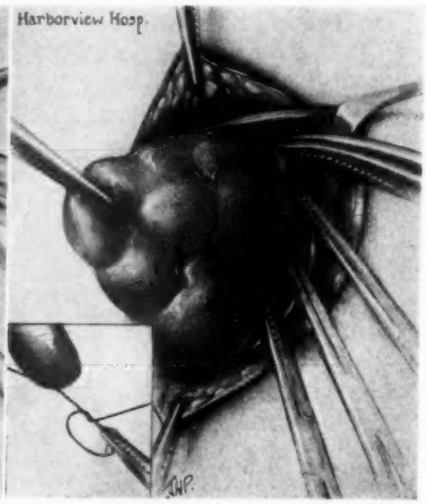


Fig. 10. Placing clamps parallel to long axis of recurrent laryngeal nerve. Inset demonstrates easy method of tying sutures.

As tetany is caused by removal, interference with the blood supply or injury of the parathyroid bodies, the greatest care should consequently be exercised when dissecting either pole or the hilus of the gland. Experience justifies the advice to keep well inside the capsule and start the dissection high on the side of the thyroid at the hilus (Fig. 9). But should a parathyroid be removed, implantation of the gland in the belly of the sternothyroid

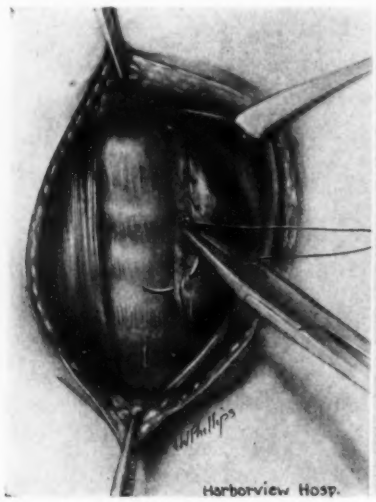


Fig. 11.

Fig. 12.

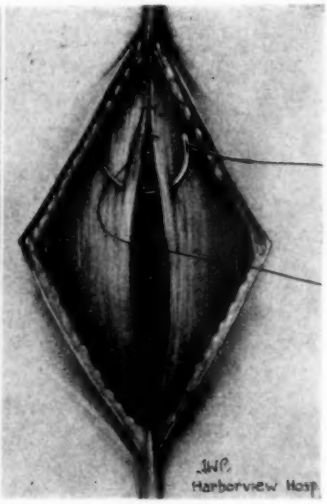


Fig. 13.

Fig. 11. Closing capsule with running stitch over resected portion.
Fig. 12. Suture of sternothyroid muscle.
Fig. 13. Closure of deep cervical fascia with running lock-stitch.

proves a prophylaxis against tetany, as soon as the blood supply becomes established. To tide the patient over the interim, parathyroid hormone is given hypodermically.

The recurrent laryngeal nerve lies normally in the groove between the trachea and the esophagus; when hemostats are applied in this area the blades of the clamps should be placed parallel to the long axis of the nerve (Fig. 10). Because large growths so often displace the nerve extreme care must be used in their excision. Injury to both nerves may mean adductor paralysis of the vocal cords, which may necessitate tracheotomy.

After resection of the gland and ligation of all vessels, before closure of the incision, the patient is brought partially out of the anesthesia and made to cough, to reveal any unsecured vessels. All bleeding points are then tied, leaving a dry field.

The capsule is approximated with a running stitch neatly covering over the residual portion of the gland (Fig. 11). The sternothyroid muscle is next closed over the trachea with one or two interrupted sutures of catgut (Fig. 12). The deep cervical fascia is then closed with either an interrupted or a running lockstitch (Fig. 13). The primary suture of the skin is expeditiously done by retracting with special hooks from each side; the margins are brought accurately together by thumb forceps and the application of Wachenfeldt Kifa suture clips (Fig. 14). Flat gauze dressings, over which a large pad is placed and held by adhesive, should be large enough to produce a moderate degree of pressure to aid in immobilizing the neck.

If a dry field is left, drainage is unnecessary. There are exceptions to this rule: in the removal of large masses where all necrosis from ligatures cannot be prevented and in anticipation of persistent oozing. Gauze drains should be used, one on each side, both pieces brought out through a single piece of Penrose tubing, an inch to one side of the mid-line.

POSTOPERATIVE TREATMENT

The patient is placed in bed with head and shoulders raised.

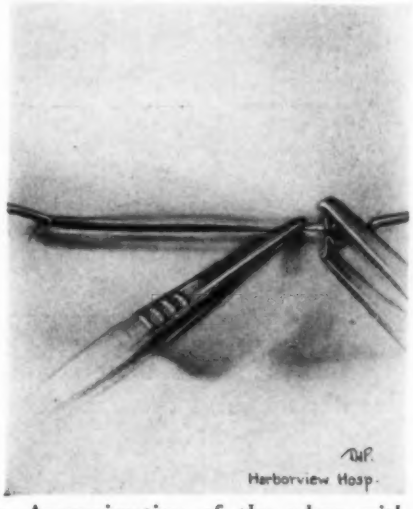


Fig. 14. Approximation of the edges with special hooks, margins brought together accurately by thumb forceps and Wachenfeldt Kifa suture clips.

Cardiac rapidity is allayed by an icebag over the precordia, care being taken not to freeze the skin. Pantopon, grain ⅓, is injected hypodermically every four hours; proctoclysis of soda and glucose is given by drop method, 30 drops to the minute, a dram of Lugol's solution being added to the first 500 c.c. of the solution.

As soon as liquids are tolerated, citrus juices are to be preferred as they aid in combating any tendency to acidosis.

Should there have been any interference with the parathyroids, 2 c.c. of Collip's parathormone serum are administered during the first twenty-four hours. This should be repeated daily or oftener on the appearance of any tetany symptoms, a positive Chvostek's sign, tingling or numbness in the fingers, prolonged nausea or a sense of cardiac constriction. The parathormone solution should be supplemented by the oral administration of calcium gluconate. If this is not tolerated by mouth, 10 c.c. of calcium gluconate should be injected into the gluteal muscles.

Unless the parathyroids have been

TABLE I

RELATION BETWEEN RISK AND RESULT IN 1900 TOTAL AND SUBTOTAL THYROIDECTOMIES

Types and Varieties	*Number* (Per (Cent	Surgical Risk			Results			
		Good (Per Cent)	*Fair* (Per Cent)	*Poor* (Per Cent)	*Cured* (Per Cent)	*Improved* (Per Cent)	*No Improvement* (Per Cent)	*Died* (Per Cent)
Diffuse toxic	45.0	70.3	9.5	20.0	82.6	14.2	2.3	.9
Nodular	49.5	79.5	10.7	9.8	88.7	9.3	1.4	.6
Sec. Basedow's	3.5	37.1	34.2	28.7	51.6	44.6	0.0	3.8
Malignant	1.3	33.3	33.3	33.3	25.0	42.7	25.0	8.3
		(6 patients alive, 5 to 10 years after operation)						
Colloid	.7	100.0	0.0	0.0	100.0	0.0	0.0	0.0

removed, there is not much likelihood of later tetany attacks, if the first postoperative week discloses neither sign nor symptom. But parathyroidectomy indicates continuous therapeutic measures to maintain the calcium balance.

TABLE II

MORTALITY RATES IN A SERIES OF 1900 THYROIDECTOMIES

Cases	*Mortality Per Cent*
First 500	1.8
Second 500	0.2
Third 900	0.7
Last 1400	0.45
Total mortality	0.9

CONCLUSION

Since the personal equation enters any phase of treatment, it is evident that poor surgical risks raise the mortality percentage. That surgery is indicated and warranted in cases that rate only as fair or even poor risks, is proved by the preceding tables, from a statistical study of 1900 cases of total and subtotal thyroidectomy.

PELVIC ROENTGENOGRAPHY

ITS VALUE AS AN AID IN GYNECOLOGICAL DIAGNOSIS*

JOHN HUBERMAN, M.D., F.A.C.S. AND DANIEL R. MISHELL, M.D.

NEWARK, N. J. MAPLEWOOD, N. J.

THE development, during the last decade, of new methods of pelvic roentgenography has aroused much interest among gynecologists, as evidenced by the number of articles recently published upon that subject. Research work in pelvic visualization was prompted by the need of additional information in the diagnosis of gynecological conditions.

The forerunners of this work were Kelling in 1902 and Jacobaeus in 1910, who introduced air, by puncture, directly into the abdominal cavity for endoscopic purposes. In 1912 Weber made *x*-rays of abdominal viscera by first introducing air into the abdominal cavity. Stewart and Stein in 1919 were the first to use this method in visualization of the pelvic organs. In the same year Rubin devised the method of introducing air into the abdominal cavity through the uterine route to determine tubal patency. In 1920 Alvarez modified Rubin's test by substituting CO_2 for air because of its more rapid absorption. The Rubin test was now combined with roentgen examinations to visualize the outline of pelvic organs. This method was termed "transuterine pneumoperitoneum." Meanwhile, in 1921, Heuser instilled lipiodal (a 40 per cent combination of iodine and poppy seed oil) into the uterus to demonstrate the internal conformation of the uterus and fallopian tubes by roentgen visualization. This method was called "uterosalpingography" or "hysterosalpingography." Stein and Ahrens in 1926 combined both pneumoperitoneum and uterosalpingography for the purpose of showing the internal and external conformation of pelvic organs at the same time.

During the past year we have utilized these procedures in a series of cases at the Newark Beth Israel Hospital, our purpose being to determine for ourselves the value of this most recent method of gynecological study. The technique employed by our department followed that outlined by Jarcho[1] in his "Gynecological Roentgenology."

The patient is prepared as for a vaginal operation; a cathartic given the day before and a soap suds enema one hour preceding the test. The patient is instructed to empty the bladder and then, having been placed upon the *x*-ray table, is prepared vaginally. The external genitalia are painted with 2 per cent mercurochrome solution and the cervix with tincture of iodine. After a modified Graves speculum has been inserted, the cervix is grasped with a short tenaculum. A special cannula, with an olive tip guard, is now inserted after the direction of the uterus has previously been determined by the introduction of a sound. This cannula has two adjustable prongs which lock the handle of the tenaculum and make it self-retaining. The speculum is now removed to eliminate its shadow from the roentgenogram.

The patient is next put in Trendelenburg position and CO_2 introduced through the cannula under manometric and volumetric control. One thousand cubic centimeters of gas is the amount usually required. Care must be exercised to introduce the gas very slowly and at a pressure not to exceed 200 mm. Hg. For pneumoperitoneal visualization alone, a roentgenogram is taken at this time. The next step is the instillation of the iodized oil. A Jarcho

[1] Jarcho, J. Gynecological Roentgenology. N. Y., Hoeber, 1931.

* Read before the Academy of Medicine of Northern New Jersey, February 2, 1933.

pressometer containing warm lipiodol is used for this purpose. Five cubic centimeters of oil are instilled into the uterine cavity and an exposure made. A second instillation of 3 to 5 c.c., depending upon the size of the uterus, follows, and another roentgenogram is taken. The cannula is now removed and the patient allowed to rest for at least an hour. At this time another exposure may be made. Twenty-four hours later the final roentgenogram is taken.

Fig. 1. Case I. Normal uterus and tubes with physiological cornual spasm.

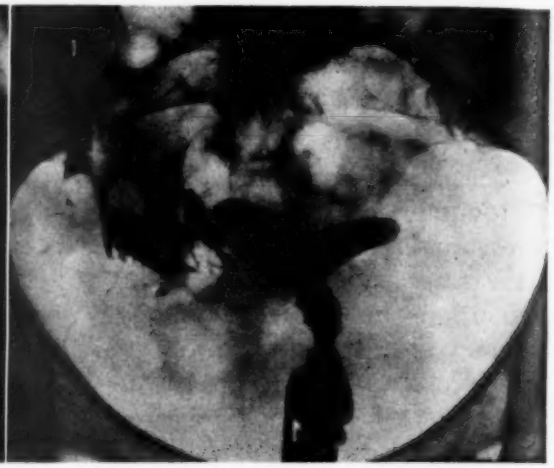


Fig. 2. Case II. Congenital anomaly, bifid uterus, absence of left tube.

We have chosen a few cases to illustrate the various phases of our work.

Case I. *Normal Uterus and Tubes with Physiological Cornual Spasm.* Mrs. M. N., thirty-four years of age, married ten years, complained of backache. A preliminary instillation of CO_2 was made. The pressure rose to 180 mm. and then dropped to 90 mm. At a pressure reading of 95 mm. 5 c.c. of oil were instilled and an exposure made; 3 c.c. of oil were next instilled and a second *x*-ray taken. Twenty-four hours later a final roentgenogram was made. This case demonstrates the normal configuration of the uterus and tubes. There is definite physiological cornual spasm of both sides with complete filling of the tubes. (Fig. 1.)

Case II. *Congenital Anomaly, Bifid Uterus.* Mrs. P. W. complained of pain in lower right quadrant. Three years previously the left tube and ovary were removed. Clinical examination disclosed a thickened right tube. In a preliminary Rubin test no gas was admitted up to a pressure of 200 mm. However, 5 c.c. of lipiodol were introduced at a pressure of 165 mm. and a roentgenogram taken. The *x*-ray findings show a bifid uterus; the left tube is not visualized, but the right tube is patent (Fig. 2). A twenty-four hour plate shows free oil in the pelvic cavity. This is a case of congenital anomaly of the uterus, with the right tube patent in spite of the insufflation test and the clinical findings.

Case III. *Chronic Salpingitis and Small Fibroid of Uterus.* Mrs. P. M. complained of pain in the right lower quadrant radiating to back and right thigh. Clinical examination shows a thickened right tube. Lipiodol, 5 c.c., as instilled at a pressure of 100 mm. and 3 c.c. at a pressure of 110 mm. The roentgenogram shows a well-outlined right tube with an accumulation of oil at the fimbriated end and very little free oil in the peritoneal cavity. The left tube is completely closed with a small defect at cornual end (Fig. 3). At operation the right tube was found to be diseased and left tube obstructed at the cornual end by a small fibroid tumor.

Case IV. *Intrauterine Tumor.* Mrs. K., forty-four years of age, complained that for the past four months her menstrual periods have been of eight to fourteen days' duration and irregular, occurring every seven to twelve weeks, being profuse and accompanied by clots. Previously her menstrual periods were regular. Clinical examination showed the uterus to be of normal size and in good position, the cervix normal, and the fornices negative.

A diagnosis of menopausal bleeding was made at the clinic. At the time of *x*-ray examination 5 c.c. of lipiodol were introduced at a pressure

Fig. 3. Case III. Chronic salpingitis in right tube, occlusion of left tube due to small fibroid tumor.

of 110 mm. and an exposure made. Then an additional 4 c.c. were instilled and a second picture taken. The *x*-ray findings show a defect the size of a quarter at the right lateral wall of the uterine cavity (Fig. 4). The right tube is obstructed at the cornual end, the left tube is patent. The diagnosis in this case is intrauterine tumor. Clinically the diagnosis was bleeding of unknown origin. The *x*-ray findings were a definite aid in establishing the diagnosis.

Case V. *Multiple Fibroid Tumors.* Mrs. L. D., forty years of age, complained for the past year of backache. The menstrual history was normal; clinical examination discloses a large fibroid uterus. This case was examined by the combined lipiodol and pneumoperitoneal methods. CO_2, 1000 c.c., was introduced, the pressure varying between 116 and 130 mm. and a roentgenogram taken. Following this an instillation of 5 c.c. of lipiodol was made. The first *x*-ray plate shows a large pelvic mass conforming to the general location of the uterus (Fig. 5). The second plate shows a large uterine cavity with a defect in the center the size of an hazelnut (Fig. 6). The size of the uterine tumor can be demonstrated by the double contrast media. Both tubes are patent. A subsequent operation confirmed all *x*-ray findings and a bisection of the uterus showed a submucous tumor corresponding to the defect seen on the second plate (Fig. 7).

Case VI. *Subserous Fibroid in Woman of Child-bearing Age.* Mrs. C. H., aged thirty-one, complained of pain in back. Menstrual

Fig. 4. Case IV. Intrauterine tumor of right lateral wall.

periods regular, every twenty-eight days, duration three days. Vaginal examination disclosed a hard irregular mass one and one-half times as large as the uterus, situated posterior and to the left. The uterus was small, anterior and seems to be connected with the mass.

Clinical Diagnosis: Large fibroid uterus. Procedure: 1000 c.c. of CO_2 were injected at a pressure of 165 mm.; 5 c.c. of lipiodol were injected at a pressure of 155 mm. *X*-ray plates show the cavity of the uterus to be well outlined and tubes patent. The fundus of the uterus is not enlarged. There seems to be a mass in the left fornix, not encroaching upon the uterine cavity (Fig. 8). At operation a fibroid tumor was found on the posterior wall of the uterus and larger than the uterus itself. This was removed and the rest of the uterus left intact. This case illustrates the value of knowing that no intrauterine growth existed and that a myomectomy was the operation of choice.

Case VII. *Calcified Fibroid Tumor.* Mrs. E. H., aged forty-six, complained of backache, frequency of micturition, menstrual periods

regular but profuse, duration six days, occurring every twenty-eight days. Examination disclosed a mass the size of an orange in the

Fig. 5. Case v. Large fibroid uterus outlined by pneumoperitoneum.

Fig. 6. Case v. Large fibroid uterus outlined by double contrast media (air and lipiodol).

right fornix, connected with the uterus, the body of the uterus being displaced to the left. Procedure: 1000 c.c. of CO_2 were injected at a pressure of 100 mm.; 5 c.c. of lipiodol were instilled at a pressure of 110 mm. Roentgenogram shows a calcified mass to the right midline the size of an orange (Fig. 9). Calcification is demonstrated by the mottled appearance of the mass. The uterine cavity shows extreme muscle tonus with a concavity of the left lateral wall. The tubes extend horizontal to the brim of the pelvis and are patent. At operation the findings were corroborated, namely a calcified fibroid of the uterus with patent tubes. On account of the age of this patient a supravaginal hysterectomy was done. Cross-section of the tumor revealed degeneration of the center of the tumor.

Let us from the very onset make this statement; uterosalpingography or pneumoperitoneum does not supplant the physical examination, any more than do other methods of *x*-ray visualization in various parts of the body, but offer a helpful adjunct in establishing a diagnosis of pelvic conditions. Any procedure that will aid in the diagnosis and particularly in the prognosis and add something to our clinical knowledge, without endangering the patient, should be used. This is particularly true in cases of sterility where prognosis and plan of treatment is so important.

The procedure is simple; however, the judicious selection of cases, after consideration of the menstrual history, and a careful general and pelvic examination; as well as a deliberate and painstaking technique, are essential to obtain satisfactory diagnostic roentgenograms. We do not advocate its use as a routine method of examination but we do believe it is valuable in helping to establish a correct preoperative diagnosis in many puzzling cases.

There are definite contraindications to this procedure namely:

1. The presence of acute pelvic inflammation, as checked by the sedimentation time and blood count.
2. The presence of a raw cervical surface with purulent discharge.
3. Uterine bleeding.
4. Pregnancy.

5. Cardiovascular disease and active pulmonary disease.

The most suitable time to perform the test is four to eight days following the menstrual period.

The benefits derived from these procedures as quoted by other observers have been corroborated by some of our findings as follows:

1. The roentgenograms show the configuration of the uterine cavity and tubes giving us a permanent record. It often enables the surgeon to plan his operative procedure beforehand and to explain to the patient what is to be expected.

2. It may obviate the need of an exploratory operation in many cases of pelvic adhesions.

3. It is of great value in showing patency of chronic infected tubes; suggesting conservative methods of treatment without resort to salpingectomy.

4. It may show encroachment upon the uterus by a mass or the presence of an intra-uterine tumor.

5. It shows evidence of congenital anomalies such as bifid uterus or infantile uterus.

6. It serves as a check-up following operations on the tubes.

tion or other complications. This we attribute to the careful observance of sterile technique and the selection of cases, keeping in mind the contraindications. We have operated upon many cases within forty-eight hours following the test and the only signs of irritation observed were engorgement of the tubes in several instances.

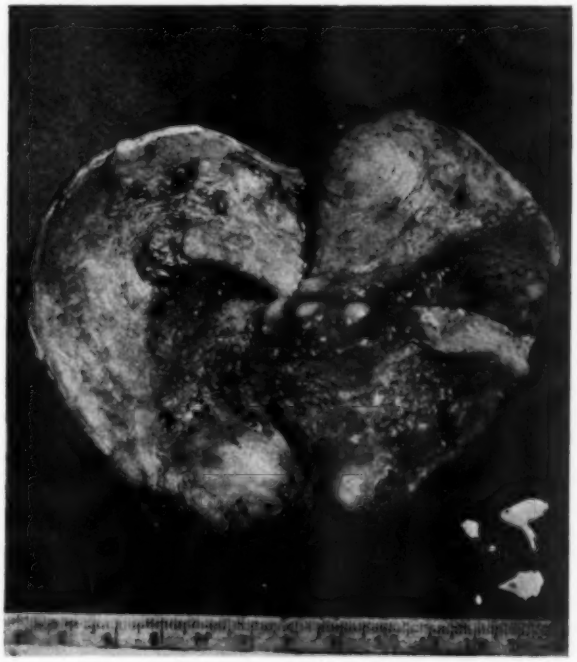


Fig. 7. Case v. Specimen of fibroid uterus shown by roentgenograms in Figures 5 and 6.

Fig. 8. Case vi. Subserous fibroid showing no encroachment upon uterine cavity.

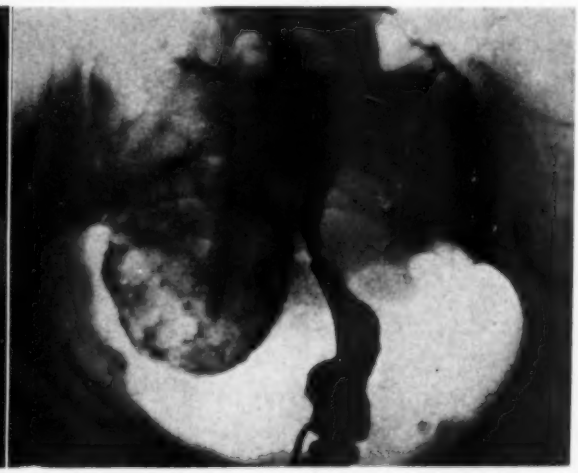


Fig. 9. Case vii. Calcified fibroid, demonstrated by mottled appearance of tumor. Concavity of left lateral wall.

7. In tubal obstruction it is possible to locate the point of occlusion, thus indicating the suitable treatment.

Of the 50 cases studied in our series none has shown untoward peritoneal reac-

The authors are indebted to Dr. Julius Jarcho for his valuable instruction and helpful suggestions in the preparation of this paper.

ACUTE APPENDICITIS

CONTROLLABLE MORTALITY FACTORS*

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DURING the last few years, there has been a noticeable increase in the number of published articles on the subject of acute appendicitis. It is not difficult to discern the reason for this. From reliable sources in various parts of the country come figures which indicate that the general mortality rate is steadily mounting. On the other hand, statistics from various European countries give astonishingly low figures, in some countries the mortality rate being one-sixth of the American figure. This vast difference suggests that either the American figures are more carefully compiled and are, therefor, more accurate, or that the American public, by and large, has not become "appendicitis conscious." I am inclined to the correctness of both suppositions.

It is generally agreed that a great many deaths from appendicitis are due to delay in seeking surgical aid. Education of the public by the same sort of campaign as is now being directed against cancer should show noticeable results in the course of time. In fact, Bower, in Philadelphia, has instituted such a program, directing a large part of the campaign towards the medical profession itself. However, there are other causes for at least a part of the general mortality of appendicitis and it is with these that this paper is concerned. I refer to the early recognition and prompt treatment of the postoperative complications. Within recent years on this service, the postoperative care of the sick cases has been actively extended and more carefully supervised and an attempt has been made to diagnose and treat the complications as soon after their inception as was possible. As a result, progressive improvement in the mortality figures has been noted.

In February, 1929, I reported, from this same service, a group of 755 cases of acute appendicitis with a mortality rate of 6.2 per cent. This series comprised the cases treated during the years 1921 to January, 1928. In July of 1932, the old New York Hospital closed its doors and moved to its present larger quarters. It seemed fitting to complete the analysis, begun in 1920 by Bancroft, of the cases of acute appendicitis treated on the Second Surgical Division until July, 1932. I have analyzed them for each year and thought it might be of interest to discuss each death and important complication as a separate problem in the hope of determining wherein treatment may have been improved upon.

During 1928, 107 cases of acute appendicitis were operated upon. Sixty-five were closed without drainage, without a death. In 23 instances, the peritoneal cavity was drained. In this group there was one death.

CASE 1. This patient was a man of thirty-nine years who was admitted on the third day of his illness. This occurred in the summer, during a severe hot spell. At operation, a gangrenous, but unruptured appendix was removed. The patient died the same day with a temperature of 110°F. Post-mortem examination was completely negative, and it was assumed that the patient died of a heat stroke.

One patient developed a mechanical ileus on the tenth postoperative day which was relieved by jejunostomy. Three days later, obstructive symptoms again supervened. A second enterostomy resulted in speedy recovery.

* From the Second Surgical Division of the Old New York Hospital, Service of Dr. Eugene H. Pool.

During this year there were 9 cases with abscess. In 4 instances, the appendix was not removed for fear that unnecessary manipulation would spread infection. This plan of procedure has many advantages and merits more general use. One patient presented interesting features. A woman of forty-six presented a large appendix abscess which was drained. After an uneventful convalescence, the wound healed. She returned two months later with another large appendix abscess which was again drained. Three months later, a third operation was performed for the repair of an incisional hernia. An intact, but adherent, appendix was removed at this time. This finding has been noted in several other instances, with the result that we question the generally accepted statement that the appendix sloughs away during an infection complicated by an abscess. Another patient developed a mechanical ileus on the fifth day which was treated promptly by enterostomy with rapid recovery. There was one death in this group.

Case II. A boy of six years was admitted on the eighth day of his illness with a large abscess and a spreading peritonitis. The abscess was drained and the appendix removed. He died the next day, and autopsy disclosed a diffuse peritonitis.

During this same year, there were 10 cases admitted with diffuse peritonitis. Five of these died.

Case III. A man of twenty-nine years was admitted twenty-four hours after onset of sudden severe upper abdominal pain, unaccompanied by vomiting. The physical findings suggested more a perforated ulcer. Operation, through an upper right rectus incision, revealed a diffuse peritonitis due to a perforated appendix. The pathology in the appendix suggested a local vascular occlusion as the cause of perforation. Death occurred in two days and an autopsy disclosed a diffuse peritonitis and bronchopneumonia.

Comment: The error in diagnosis, followed by unnecessary manipulation through a high incision undoubtedly was a factor in this mortality. I would like to call attention to this type of appendicitis, of which we have had seven or eight instances. The onset is usually quite sudden, unaccompanied by vomiting, the pain is generalized and, as a rule, does not localize. The physical findings suggest the diagnosis of a perforated peptic ulcer because of generalized abdominal tenderness and rigidity. This diagnosis is fortified by the short duration of the illness and the absence of localization. The findings at operation suggest a local vascular accident resulting in a sudden perforation of the appendix without any walling-off of the pathological process. The prognosis in this type of case should be guarded, first, because the peritoneal cavity has been suddenly flooded with highly infectious material and secondly, because the surgeon usually makes a high incision under the diagnosis of perforated ulcer, resulting, necessarily, in extensive manipulation.

Case IV. A child of ten was admitted on the tenth day of illness with signs of a ruptured appendix abscess and diffuse peritonitis. At operation, a large abscess was drained. Nothing further was done. Death occurred on the following day, and autopsy disclosed a widespread peritonitis.

Case V. An obese woman of forty-five, with a two day history, was admitted in a state of collapse. The surgeon felt that a diagnosis of acute pancreatitis should be entertained. Operation revealed a gangrenous appendix with a local pelvic peritonitis. The patient died on the second day with signs of a fulminating pneumonia. No post-mortem examination was permitted.

Comment: Although this death was ascribed to pneumonia, careful survey of the facts certainly seems to indicate that the error in diagnosis called for an upper abdominal incision with resultant surgical manipulation to deliver a pelvic appendix; a general spread of the already existing pelvic peritonitis probably followed.

Case VI. A child of six was admitted on the third day of illness with signs indicating

a diffuse peritonitis. Operation revealed a perforated gangrenous appendix, with diffuse peritonitis and walled-off abscesses between loops of bowel. Death occurred sixteen hours later and autopsy disclosed a generalized peritonitis.

Comment: It is probable that this patient's disease was too far advanced to be influenced by any form of treatment. It is a well-known fact that children do not react well to the Ochsner method (Woodall).

Case vii. A boy of seventeen was admitted thirty-six hours after the onset of symptoms. Operation disclosed a gangrenous perforated appendix with peritonitis. He did well with supportive measures, as continuous intravenous drip of glucose, etc. On the nineteenth day, death occurred suddenly. Autopsy revealed a pulmonary embolus with a large area of infarction. The peritoneal cavity was clean.

During 1929, 108 patients were operated upon. Sixty cases were closed and 26 were drained intraperitoneally. There were no deaths and no complications. Sixteen patients were admitted with appendix abscess. In 7 instances, the abscess was drained and no attempt was made to hunt for the appendix. One patient died. The findings merit description.

Case viii. A man of thirty-six was admitted one week after the onset of his disease. The main symptoms were generalized abdominal pain, vomiting, fever, night sweats, and abdominal distention. *Examination* disclosed marked distention with exquisite tenderness in right upper quadrant. In this situation a large mass was palpable. Temperature was 103°F., white blood cells, 26,800, polymorphonuclears 93 per cent. Exploration through a rectus incision disclosed a large walled-off abscess cavity in the region of the right lobe of the liver. The pus cultured B. coli. Because of the well-defined limiting walls of this cavity, further exploration was deemed inadvisable. The character of the pus suggested the appendix as the primary focus. In spite of vigorous supportive therapy, the patient went down hill rapidly, and died on the fourth day. Autopsy disclosed a perforated appendix with a suppurative pylephlebitis. There was one small liver abscess.

In 9 instances, the appendix was removed. There was one death.

Case ix. A thirty-three year old man was admitted on the third day of his illness. Pain and fever were prominent symptoms. He had had four distinct chills. The possibility of a phlebitis of the appendicular or ileocolic veins was discussed before operation. A gangrenous appendix with an abscess in the mesoappendix was found. The latter structure was removed completely, its point of division being beyond the seat of pathology. Numerous blood cultures were negative. Death occurred on the fourth day. Post-mortem examination revealed a thrombophlebitis of the ileocolic veins. The portal vein, liver and peritoneum were normal.

Comment: It is doubtful whether this finding at autopsy was the cause of death. The exact reason for this mortality was not demonstrated. We have seen an appreciable number of cases presenting chills as a prominent symptom. Operation revealed either an abscess in the mesoappendix or a visible phlebitis of the appendicular veins. We have never practiced purposeful dissection and excision of the ileocolic veins in such cases, as recommended by a few writers, feeling that such a procedure was unwarranted in the presence of infection and unnecessary, except in very rare instances.

In the same year, 6 cases were admitted with diffuse peritonitis, and 2 of these patients died.

Case x. A child of five was admitted on the fourth day of the disease. Operation disclosed a perforated gangrenous appendix with diffuse peritonitis. With supportive measures the child did well. On the tenth day, a small abscess in the right lumbar gutter was drained. Recovery seemed assured until the eighteenth day when symptoms of peritoneal irritation appeared again. Death occurred three days later. Autopsy disclosed a diffuse peritonitis due to a perforated ulcer of the transverse colon. Another ulceration, of a similar nature, but not perforated, was found a few inches away. Microscopic sections of these lesions revealed nothing of note.

Comment: Considerable discussion arose as to the cause of these ulcers. The pathologists were of the opinion that they were of toxic origin and cited other instances occurring in children suffering from acute infectious diseases.

Case xi. A boy of seventeen was admitted two days after onset of symptoms. A gangrenous appendix with a perforation near the cecum exuding fecal material, and a diffuse peritonitis were found at operation. In spite of vigorous supportive measures, death occurred on the third day. Autopsy disclosed a generalized peritonitis.

In 1930, 89 cases were treated on this service. Fifty-seven were closed without drainage, without a death. Aside from the abscess and peritonitis cases, 14 were drained. There was one death.

Case xii. A sixty-eight year old woman was admitted on the third day of illness. A perforated gangrenous appendix was removed and drainage instituted. A severe infection of the wound developed. A rapidly spreading erysipelas of the abdominal wall ensued, and the patient succumbed on the eighth day. Blood cultures revealed Streptococcus hemolyticus. At post-mortem, an infection of the abdominal wall and a small pelvic abscess were found.

Eleven cases were admitted with an appendix abscess. In 6, the appendix was removed, and in 5 simple drainage was done. There was one death in each group.

Case xiii. A man of thirty-three was admitted forty-eight hours after onset of symptoms. At operation, performed by the house surgeon, an appendix abscess was found. This was entered into before provision had been made for protection of the peritoneal cavity. Soiling occurred. *Postoperatively*, temperature remained elevated, distention was marked, vomiting was persistent, and there was hiccup. On the sixth day, a jejunostomy was done under local anesthesia. No peritonitis was visible at this time. Following this procedure, vomiting, hiccup, and distention subsided. Five days later, digital exploration of the original McBurney incision evacuated a collection of pus in the right lumbar gutter. This patient received three transfusions. Finally, symptoms of renal insufficiency developed and the patient died of uremia on the nineteenth day. No autopsy was permitted.

Comment: A serious technical error was committed in this case. We have always made it a practice to carefully pack off the peritoneal cavity before entering an appendix abscess. The site of drainage should be as far lateral as possible, and the contents are aspirated by suction in an attempt to minimize the spilling.

Case xiv. A boy of ten was admitted on the ninth day of his illness with a large mass in the right lower quadrant. At operation, a large retrocecal appendix abscess was drained. The appendix was not found. Soon after operation, a continuous intravenous drip of 5 per cent glucose in saline was started. On the third day slight general edema was noted. There was fluid in both chests. The intravenous therapy was discontinued and the chest fluid was aspirated. On the fifteenth day, a large pelvic abscess was drained by rectum. However, the patient went down hill rapidly and died a few days later. Post-mortem examination showed a diffuse peritonitis with localized walled-off collections of pus throughout the abdominal cavity.

Comment: We have found the continuous intravenous drip a valuable form of therapy in the treatment of these sick cases. It maintains water balance, helps to allay thirst and supplies body fuel. However, its administration must be watched carefully. The anasarca which developed in this case should not have occurred.

Seven patients were admitted with peritonitis already present. Three of these died.

Case xv. A twenty-one year old man was admitted three days after onset of symptoms. He appeared very ill and was markedly tender over the entire abdomen. Operation revealed a diffuse peritonitis with a perforated appendix lying in the lumbar gutter. Because of the poor general condition of the patient and the rather inaccessible position of the appendix, (these are the surgeon's notes) the appendix was not

removed. Drainage was instituted. Postoperatively, the temperature remained high and distention developed. In spite of supportive therapy, death occurred on the eighth day. Autopsy showed a diffuse peritonitis, a pelvic abscess, and bronchopneumonia, and an acute vegetative endocarditis of the mitral valve.

Comment: It would seem, after weighing the factors in this case, that it probably would have been wiser to remove this appendix. It was not walled-off and probably continued feeding the peritoneal cavity. This is quite different from conditions found in a walled-off appendix abscess where simple drainage, without appendectomy, is often a safer procedure.

Case xvi. A boy of eighteen was admitted on the second day of his illness with a diffuse peritonitis. At operation, a perforated gangrenous appendix was removed. After operation, the intra-abdominal infection progressed and death occurred on the fourth day. No autopsy was permitted.

Case xvii. A baby of seventeen months was admitted three days after onset of symptoms, practically moribund. Considerable discussion arose concerning the advisability of operation. The surgeon felt that the only chance was offered by a rapid operation. Accordingly, a perforated gangrenous appendix was removed in six minutes. Diffuse peritonitis was evident. The child died on the following day.

In 1931, 86 cases were admitted for treatment. Fifty-one were closed without drainage. One of these developed a postoperative pneumonia, followed by an empyema. A hemolytic Staphylococcus aureus was isolated from sputum, blood and pleural cavity. Following thoracotomy, recovery was rapid. In 16 cases, drainage was instituted. There were no complications in this group. Eleven patients came in with an abscess already present. In 4 of these, the appendix was not removed. One patient developed a pelvic abscess which was drained by rectum. In the remaining 7, the appendix was removed. There was one death.

Case xviii. A boy of seventeen was admitted on the fifth day of illness. Operation revealed a retrocecal appendix abscess. The appendix was removed and drainage instituted. Postoperatively, a peritonitis developed. Because of persistent vomiting and distention, jejunostomy was performed eleven days later. Evidences of peritonitis were visible at this time. The jejunostomy tube worked well and the patient improved. The tube was removed on the sixth day. Ten days later a large pelvic abscess was drained by rectum. Distention and vomiting recurred. A second enterostomy was performed. At this operation, two large intraperitoneal collections of pus were evacuated. Because of adhesions and fixation of the loop of bowel, the enterostomy was performed by the purse-string method rather than by the Witzel technique. The septic course continued and a jejunal fistula developed at the site of the second enterostomy. This was treated by the Potter method, the use of the Levin tube and suction. Five weeks later, the jejunum was resected at the site of fistula and an end-to-end Murphy button anastomosis performed. The patient continued septic and died three months after the original operation. Autopsy showed a perforation of the jejunum near the anastomotic site, diffuse purulent peritonitis and pyelonephritis.

Comment: Three errors were committed in the management of this case. At the first operation, the surgeon should have been content with simple drainage of the abscess. Removal of the appendix was technically difficult and the infection was undoubtedly disseminated. Secondly, at the time of the second jejunostomy, the discovery of two large intra-abdominal abscesses should have deterred the surgeon from opening the bowel. Finally, the resection of the jejunum should have been deferred, inasmuch as some improvement was taking place. This operation was performed under particularly unfavorable conditions.

During this year, 8 patients were admitted with peritonitis already present. There were 2 deaths.

Case xix. A woman of seventy years was admitted with a ten hour history. Operation revealed a ruptured appendix with diffuse

peritonitis. The patient died on the sixth day, and postmortem showed a diffuse peritonitis.

Case xx. A man of forty-six years came in with symptoms of an infection of eight hours' duration. Vigorous catharsis had followed many medications. Operation disclosed a perforated appendix with diffuse peritonitis. Three days later an enterostomy was performed. Death occurred two days later. Autopsy showed a diffuse peritonitis.

In 1932, from January to July, 43 cases were admitted for treatment. Twenty-four were closed and 14 were drained. Four patients were admitted with an abscess present. In 3 instances, the appendix was not removed. One patient, admitted with peritonitis, developed a secondary abscess near the midline and recovered following drainage. There was no mortality during 1932.

RÉSUMÉ

In 1928, there were 107 cases with 7 deaths, a mortality of 6.5 per cent. In 1929, 4 deaths occurred in 108 cases, or 3.7 per cent. In 1930, 89 cases were treated and 6 died, the mortality rate being 6.7 per cent. In 1931, the rate was 3.5 per cent, 3 deaths occurring in 86 cases. In 1932, 43 cases were treated without any mortality. In the total group of 433 cases, there were 20 deaths, or a general mortality rate of 4.6 per cent.

In the entire group, secondary pelvic abscess developed in 5 patients. All were drained by rectum. During this period, six enterostomies were performed, 2 patients having two enterostomies each. One patient died because the bowel drainage was performed in the presence of an abscess. I would like to call attention to the high autopsy figures. In 20 deaths, 18 post-mortem examinations were obtained.

DISCUSSION

In this study, only those cases proved to be acute appendicitis by pathological section or by obvious gross appearance, were included. In general, the McBurney incision was used. When any doubt as to the diagnosis existed, a rectus incision was made. It is interesting to note that there was not one instance of major wound infection in the 257 cases that were closed without drainage. The care with which the abdominal wall opening was protected during removal of the appendix and inversion of the stump is the probable explanation of these interesting figures.

When drainage was indicated, the cigarette drain was used. In general, 2 of these were inserted, one to the region of the appendix stump and the other through the parietal peritoneum. The reason for the second drain was to insure a wider drainage tract upon its removal. When indicated, additional drains were placed to the pelvis, lumbar gutter, etc. *In all drained cases, no sutures were placed in the incision except occasionally in the parietal peritoneum.* I reported this change in technique in 1929, as formulated by Dr. Pool, and called attention to the great improvement in appearance of these wounds postoperatively, the almost complete absence of fascial slough, and the reduction in the incidence of incisional hernia by almost two-thirds. This technical detail merits more general use.

While the major portion of this communication has been concerned with a critical analysis of the complications and deaths, still, many of the patients included in this study were in the seriously ill group. Treatment was actively extended to these cases and, I am confident that the lowered mortality can be attributed, in great part, to the concerted efforts of the entire staff in their direction. I am sure that the objection cannot be raised that a seasonal variation in the disease with its attendant fluctuation in virulence may be responsible for this improvement in figures. In comparing this series with the preceding ones, one finds proportionately, just as many cases with peritonitis, abscess or gangrene of the appendix and just as many seriously ill patients in the early and late decades of age grouping.

It is difficult to describe, in extenso, the various methods that were utilized in treating these patients. None of them are new or spectacular. However, at all times, efforts were made to individualize the treatment of each case and to consider each as a separate problem. Judicious use was made of intravenous glucose therapy by the continuous drip technique, small transfusions, avoidance of routine catharsis and rectal drips, supportive dietotherapy and sunlight treatment, modified Ochsner regime following operation, etc. The great majority of these operations were performed by members of the staff with considerable experience, men who had some years before passed out of the novice class. In going over the previous series of cases, it was interesting to note that the mortality rate rose perceptibiy following the appointment of a new younger member to the staff.

Emphasizing again the original premise of this paper, the mortality rate of acute appendicitis is directly dependent upon the length of time between the onset of symptoms and diagnosis and operation. However, much can be done to help decrease this rate by careful postoperative care and prompt intelligent treatment of the various complications.

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URETERAL TRANSPLANTATION TO THE RECTOSIGMOID

FOR EXSTROPHY OF THE BLADDER, COMPLETE EPISPADIAS, AND OTHER URETHRAL ABNORMALITIES WITH TOTAL URINARY INCONTINENCE: A STUDY OF 85 OPERATIVE CASES*

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ONE of the most brilliant advances in surgery was the treatment of exstrophy of the bladder by the transplantation of the ureters into the rectosigmoid. Such an operation permits urinary control by a competent anal sphincter and removal of the exposed, irritated bladder, which is prone to the formation of carcinoma. When the operation is properly performed, it prevents dilatation of the ureters and pyelonephritis, sequelae which cause death in most cases in which exstrophy of the bladder is allowed to remain.

The application of transplantation of the ureters to the rectum has been adopted as the procedure of choice in the treatment of total epispadias with complete urinary incontinence. It has been equally well established in the treatment of other lesions of the bladder and urethra, in which, as the result of irreparable injury to these structures, constant urinary leakage occurs. Its use in treatment of large, vesicovaginal fistulas that are not responsive to plastic methods of closure, has been a later successful application of ureterosigmoidal transplantation. This procedure has also been used preliminary to total cystectomy for extensive and otherwise inoperable carcinomas of the bladder and has been recently favorably commented on by Coffey.

Prior to 1912, plastic methods used in the treatment of exstrophy of the bladder consisted, for the most part, of transplantation of the trigone containing the ureteral orifices en bloc into the sigmoid.[6] The risk of this operation was great and the results were not entirely satisfactory. In 1909, at a meeting of the Southern Surgical Association, R. C. Coffey described a method of submucosal transplantation of the common bile duct into the intestine and in closing the discussion of this paper, made the suggestion that this same principle might solve the problem of ureteral transplantation.[2] A year later, Coffey presented, before the American Medical Association, his experimental studies on submucosal implantation of the severed ureter and common bile duct into the intestine. Quoting from a paper: "Of nine dogs in which the ureters had been transplanted by the submucous method, . . . the five which recovered from the immediate effects of the operation showed undamaged kidneys and undilated ureters, when the dogs were killed at periods of 60 to 167 days after operation." The efficiency of such a submucous mechanism contrasts sharply with the renal infection and dilatation of the ureters in six dogs in which the ureters were implanted directly. "Five died from pyonephrosis as a result of the operation, while the sixth, when destroyed sixty-one days later, was found to have a totally destroyed kidney on the side in which the ureter was directly implanted."[3]

In 1911, Stiles presented before the American Surgical Association a report of 2

* Read before the New York Branch of the American Urological Association, March 22, 1933, and before the Wayne County Medical Society, Detroit, Mich., March 21, 1933.

cases in which he implanted the ureters into the sigmoid by a method which aimed at making a valvular opening; by this he hoped to lessen the risk of ascending infection.[10,11] This method was essentially the same as that described by Witzel for use in gastrostomy. The ureteral transplantation proved to be superior to transplantation of the trigone and ureteral orifices.

In 1912, C. H. Mayo was the first to apply Coffey's principle of submucous transplantation to the ureter in the treatment of a patient with exstrophy of the bladder.[6,7] Quoting from Coffey:[3]

> Since that time, while Doctor C. H. Mayo has never claimed to have added any essential point to the technic of the operation, he has added a number of personal touches to the management of these cases which have materially helped to clinicalize the procedure and because of his enormous experience, his remarkable clinical judgment and the benefits his advocacy carried to the profession, he did more than anyone else to prove the soundness of the procedure.

Coffey's first opportunity to use the procedure on a patient was in 1913.[3] In April, 1931, there was presented before the German Surgical Congress a summary of the results in 76 cases of exstrophy of the bladder, including cases of complete epispadias in which the operation was performed at The Mayo Clinic by the method described by C. H. Mayo, using the Coffey principle of submucous transplantation. This method consisted of transperitoneal transplantation of the ureters to the sigmoid in separate stages with an interval of twelve to fourteen days between operations. The transplantations were done without the use of tubes or catheters. The number of these cases has now increased to eighty-five.

In the last seven years, one of us (Walters) has operated for exstrophy of the bladder on twenty-two of these patients, two of whom each had a solitary kidney. In addition, three other patients have been similarly operated on. One of these three patients had a contracted bladder secondary to tuberculosis of the right kidney, which had been previously removed. The other two patients had complete urinary incontinence, congenital in one case, and in the other the result of destruction of the urethra from radium. One of the 25 patients died.[16] That patient was a woman aged twenty-five years, 5 feet in height and weighing 180 pounds. Her right ureter was transplanted to her sigmoid. Apparently this operation was successful. Accurate submucosal transplantation was difficult because an exceedingly short mesocolon prevented satisfactory mobilization of the sigmoid; thus, the submucosal transplantation was none too accurately accomplished. Nevertheless, the patient passed urine in normal quantities through the rectum subsequent to this operation. Fourteen days after this procedure, a stone 3.5 cm. in diameter was removed from the lower part of the left ureter. The left kidney moreover was infected. The patient died from renal infection, but the death has been charged to ureteral transplantation for exstrophy, for the postmortem examination disclosed, besides infection of the left kidney, some necrosis of the transplanted portion of the right ureter and a small psoas abscess without peritonitis. It would probably have been better to have removed the stone from the left ureter and determined the exact condition of the left kidney before carrying out the right ureteral transplantation.

UNILATERAL VERSUS BILATERAL URETERAL TRANSPLANTATION

C. H. Mayo's experience has been, and it has also been ours, that it is unnecessary to use either tubes or catheters in the transplantation of the ureters to the sigmoid, if one ureter of normal size is transplanted at a time. Our experience has proved that in treatment of exstrophy of the bladder and other congenital abnormalities of the bladder and urethra,

with total incontinence, the risk of such operation is far less for young children than that of simultaneous, bilateral ureteral transplantation. In the last few years, various reports of the results of ureterosigmoidal transplantation have appeared in the literature of this and other countries,* and good results have been reported in cases of unilateral and of bilateral, simultaneous transplantation. A review of these cases clearly establishes the fact that bilateral, simultaneous transplantation of the ureters to the sigmoid for exstrophy of the bladder, especially among children, carries a mortality rate far in excess of transplantation when done in separate stages. Indeed, on the basis of cases, not operations, this difference in mortality rate has been as great as 15 to 20 per cent for bilateral, simultaneous transplantations compared to 4 per cent when the ureters are transplanted separately.

Hugh Cabot's report of 14 cases of exstrophy of the bladder, in which the ureters were transplanted in separate stages without a death, is a striking example. The causes of death reported in the cases in which simultaneous transplantations have been performed elsewhere have consisted for the most part of sloughing of the ureter from the pressure of ureteral catheters, and shock. This former cause is usually lacking, and shock does not occur, in transplantation of one ureter and then the other, when tubes or catheters are not used.

The time during which the 25 patients previously mentioned were in the hospital, compared with the time required in hospital for simultaneous, bilateral ureteral transplantation, averages approximately the same. The series of 25 cases includes many in which, in addition to transplantation of the ureters and removal of the bladder, a plastic operation has been done on the penis either at the time the bladder was removed or shortly afterward. In comparing the postoperative progress in the 25 cases and in those reported by Coffey,[3] it was noted that the reactions from the operations were strikingly more severe and more prolonged, as indicated by the mortality or fever and increase in pulse rate, when both ureters were transplanted simultaneously. It has been the experience at the clinic that when one ureter has been transplanted at a time, postoperative reactions are usually slight. The period of fever and increase in pulse rate lasts for a few days subsequent to transplantation of the first ureter only, and following transplantation of the second or left ureter very little reaction occurs. With the patient in good condition, removal of the exstrophied bladder, and a plastic operation on the penis, are both regarded as operations without appreciable risk.

It is to these factors, particularly division of the operation into stages, that we attribute our low mortality rate in ureterosigmoidal transplantation for exstrophy of the bladder of children. When the exstrophy, however, has been allowed to remain until adult life, in some instances obstruction of the ureters and infection of the kidneys have occurred to a greater or less degree. This has been evidenced by dilatation of the ureter, particularly of the lower third, and occasionally the pelvis and calices, as disclosed by intravenous urography. Hence, the greater risk of ureteral transplantation for exstrophy is to the adult.

The ureteral catheter is useful in certain cases in which the ureters are dilated, and in transplanting the ureter from a solitary kidney into the sigmoid, it may be advisable to use such a catheter to prevent the possibility of temporary renal obstruction occurring from edema at the anastomosis in the first few days subsequent to operation.

In a case in which operation recently was performed, and a solitary kidney was present, edema at the ureterosigmoidal anastomosis occurred. Urine was not found to enter the rectum for seventy-two hours subsequent to

* 1, 3, 5, 6, 7, 8, 11, 12, 14, 15.

operation. Emergency ureterostomy was performed, the ureteral catheter being passed down the ureter, through the anastomosis, into the rectum. Although when the catheter reached the anastomosis and was pushed through it with considerable force, one gained the impression that the obstruction was not complete; nevertheless, it was sufficient to prevent passage of urine into the rectum. The value for urea was 120 mg. in each 100 c.c. of blood, there was some edema of the face and back, and when the ureter was opened urine spurted out under pressure. The ureteral catheter was removed from the rectum, through a proctoscope, eight days later, following which the patient passed urine normally through the anastomosis into the rectum, and the incision healed. The value for urea returned to a normal level within two weeks, and the patient left the hospital in excellent condition after the bladder had been removed, and skin had been grafted on the denuded area. The intravenous urogram, fifty-one days subsequent to relief of the obstruction indicated that the pelvis and calices of the solitary kidney were practically normal.

EFFECT ON THE KIDNEYS

In the paper read before the German Surgical Congress,[14] and previously mentioned, detailed consideration was given to the effect of ureterosigmoidal transplantation on the kidneys: (1) the incidence of clinical evidence of renal infection subsequent to operation, (2) renal function determined by means of estimation of blood urea nitrogen, and (3) preoperative and postoperative renal function determined by intravenous urography.

In general it may be said that when the ureters are properly transplanted to the rectosigmoid, using Coffey's submucous method of transplantation, without the use of catheters, or tubes, little dilatation of the pelves, calices, and ureters should occur and consequently little infection. This is well illustrated in the following case:

In 1916, C. H. Mayo transplanted the ureters into the rectosigmoid and excised the bladder of a man aged twenty-five years. The operation was done in stages. This patient, now aged forty years, occasionally returns to the clinic for observation and affords a striking example of the best results in such cases. He has not been ill since his operation. There has never been evidence of renal infection. Intravenous urograms revealed the pelvis, calices and ureters to be normal in size, and the dye was of normal concentration in these regions. The value for blood nitrogen also was normal. Retention of urine in the rectum by a competent rectal sphincter enables him to hold urine from four to six hours during the day and from six to eight hours during the night.

Somewhat similar progress has been made by two other patients on whom C. H. Mayo performed ureterosigmoidal transplantations for exstrophy of the bladder in 1913 and 1917 respectively.[15] These two patients were women; following their operations they married, and the woman operated on in 1913 was delivered of normal twins in 1924 and the other one was delivered of a normal child in 1924. Excellent operative results have persisted. The former of these two patients had the ureterosigmoidal transplantation at the age of thirty years.

Referring again to the report given in Germany:[14] In 50 per cent of cases there has not been evidence of renal infection; in 21 per cent, slight evidence of mild renal infection has occurred at infrequent intervals. Usually the infection is manifest by the presence of fever lasting for a day or two, without lumbar pain. However, there may be weeks and months of normal and comfortable existence between episodes. Infection is usually mild, and if the patients are children they continue to develop satisfactorily, and many of them become immune to the infection. Further evidence of the mildness of the infection in the group of 76 cases is the fact that of the 9 patients who died at home, in periods varying from one to seven years subsequent to the operation, only one presented definite evidence of renal infection as the cause of death.

The postoperative length of life, up to 1931, had been more than five years since

operation on 27 of the 76 patients and ten years since operation on thirteen. Twenty patients who were operated on at the clinic were aged five to nine years; forty were operated on between the ages of fifteen and thirty-four years. In the experience of the clinic four of the exstrophied bladders have been carcinomatous.

URINARY CONTROL

If ureterosigmoidal transplantation is carried out in the presence of a satisfactorily functioning rectal sphincter, the patient will be able to retain the urine in the rectum on an average of from two to four hours during the day and from three to five hours during the night; such a condition existed when of the 76 cases, 59 were traced and were known to be living.

Experience has shown that it is unwise to carry out ureteral transplantation on children until the child is old enough (usually after the age of three years) to have gained good rectal control of fecal material. In the group of 76 cases reported, urinary control by rectal sphincter was uncertain in nine. In only two of the cases was rectal control definitely lacking, and in these there was evidence prior to operation that the rectal sphincter was not competent. Fecal incontinence was reported and absence of a gripping anal sphincter was noted on examination of the rectum. In the other 7 cases there was partial control.

In all the cases encountered, careful examination of the rectal sphincter should be made to determine its competency before ureteral transplantation has been made. This test, to determine whether the child has complete control of the rectal content, consists in inserting the gloved forefinger into the rectum. If the history reveals rectal competence for fecal material, and if the anal sphincter is elastic and gripping, rectal control of urine will prove to be satisfactory. On the contrary, if there is a history of partial incontinence for liquid feces and the anal sphincter has a sclerotic feeling, the patient's relatives should be warned that control of passage of urine by the rectum may not be completely satisfactory. As a result of this careful examination, in the series of 25 cases referred to, rectal control of urine has been complete and satisfactory in all but one case. In this case, incomplete rectal control of urine was predicted on the basis of the criteria mentioned.

PLASTIC OPERATION ON THE EXTERNAL GENITALIA

In the female with exstrophy of the bladder, the vagina, uterus, tubes and ovaries are usually normal. Entrance into the vagina is through the small hymen that lies directly below the exstrophied bladder. In such cases, of course, there is no indication for any plastic procedure on the external genitalia.

In the male, however, associated with the exstrophy of the bladder there is always malformation of the penis. The dorsal surface is flattened, as if half of a cylinder had been cut away. From a practical as well as a psychologic standpoint, we are convinced that restoration of the contour of the penis by plastic operation is advisable. In a few cases in which we have attempted to carry out such a procedure in a way to maintain a channel for the transmission of seminal fluid, the results have not been satisfactory.

Our experience has shown, however, that the penis can be restored to its cylindrical contour by a simple operative procedure, consisting of removal of the skin on the dorsum of the flattened penis then bringing the raw edges together, and maintaining them in this relationship with silkworm sutures until healing occurs. Although, with this method, discharge of seminal fluid will occur at the base of the penis during ejaculation, yet construction of a penis of normal contour is very acceptable to the patient, and is successfully accomplished in a high percentage of cases.[13,17]

COFFEY'S THIRD METHOD OF ANASTOMOSIS (THE "ASEPTIC SUTURE METHOD"), AND OTHER METHODS

Recently, an aseptic suture method of ureterosigmoidal transplantation has been described as being successfully carried out experimentally as well as in some clinical cases.[4] In this method, the end of the ureter is ligated, and the colon is prepared for the submucous anastomosis in the usual way, but the lumen of the bowel is not opened except as this is accomplished by a tightly tied suture ligature transfixing the ureter and the mucous membrane of the colon. Fistula anastomosis is established spontaneously in most instances in from three to five days as a result of necrosis from pressure by the suture. Coffey stated that he used the aseptic technique to prevent infection in the anastomosis and along the ureter from the opening made into the lumen of the bowel.

Our objections to such a method are that although such suture will in most cases establish fistulous anastomosis, it may fail to do so, as in cases recently reported by Pedroso and Nitch. When such a method has been used experimentally by us, on animals, obstruction of the urinary flow, even though temporary, has been accompanied by marked infection of the kidney. Furthermore, in observing animals on which the method was used, it has been noted that marked hydronephrosis, with considerable destruction of renal tissue, has persisted in several instances, even though the anastomosis had established itself within three or five days. This has not been true when accurate submucosal anastomosis has been made experimentally by us, using the original Coffey method.

Of more importance from the clinical standpoint is the fact that infection at the anastomosis, or hydronephrosis, occurs very seldom if submucosal anastomosis is accurately carried out, as originally described by Coffey, without use of tubes or catheters, and as used in the entire series of 85 cases which form the basis of this paper. Hence, for the present, we can see no necessity of, or advantage in, use of a method which results in questionable accuracy of anastomosis, to prevent a complication which in our experience happens with great infrequency.

Finally the use of catheters, as well as simultaneous bilateral transplantation of the ureters, have their indications. In all probability, catheters are best used when the kidney and ureter are solitary, to prevent the possibility of edema of the anastomosis temporarily obstructing the passage of urine, such as occurred in the case previously mentioned. When the ureters are dilated the catheter serves as a scaffolding for the anastomosis. In cases of carcinoma of the bladder in which the growth is too extensive for methods other than total cystectomy, it is probably better to take a higher primary operative risk, and to transplant the ureters into the colon and remove the bladder rather than to spread the operation over a longer period by performing it in multiple stages. In the cases of carcinoma of the bladder the risk of any operation is high, and the problems presented by ureteral transplantation in the presence of carcinoma are very different from those which occur in the presence of exstrophy of the bladder. They cannot be considered here.

CASES OF EXSTROPHY OF THE BLADDER IN WHICH OPERATION WAS NOT RECOMMENDED

Other than the patients operated on, we have observed 42 patients with exstrophy of the bladder for whom operation was postponed or not advised. In this group were many children less than three years of age, who were too young to have been taught rectal control. The group of 42 patients also included several children with congenital weakness of the rectal sphincter. There were 2 patients with evidence of renal insufficiency, as shown by an elevated value for blood urea; in one case this value was 134 mg. It is of interest to note that 13 patients were more than twenty years of age; several of these were more

than forty years of age, and one was aged more than fifty years. In all of these cases except one, renal function was normal. It is frequently surprising to note how the patients may become inured to their condition and how they are often able to carry on the normal activities of life. For two patients aged more than forty years, operation was not advised because of their comparative comfort. One patient had adapted a metal urinal to his bladder, which kept him dry and comparatively free from odor. In two cases there was bilateral lithiasis and infection, so extensive that operation was inadvisable, and a secondary, inoperable carcinoma of the bladder was found in two others. In practically every case roentgenograms of the pelvis gave evidence of absence of the symphysis pubis, but this apparently caused no inconvenience. It is surprising how uniformly this defect occurs and how little other evidence there is of congenital deformity. Apparently the defect in embryonic life is confined entirely to this region.

PREOPERATIVE CONSIDERATIONS

Intravenous urography is of great value in the diagnosis and treatment of exstrophy of the bladder and should be used as a routine, both before and after operation. This method allows of estimation of renal function, visualization of postoperative results and elicitation of evidence of pyelectasis and ureterectasis and of renal infection and consequent deformity.

The comparative degree of visualization and the time within which visualization becomes possible, together give a fairly accurate estimate of renal function. With absence of visualization one can infer that destruction of renal function is so great that ureteral transplantation on the side affected would hardly be advisable. Occasionally reflex inhibition of excretion, such as may occur with lithiasis, will temporarily disguise the potential renal activity. With partial or delayed visualization the degree of deformity of the pelvis would be deciding factors in regard to the advisability of carrying out a re-implantation procedure. The well-known method of estimating the comparative renal function by means of indigo carmine is still of value. Complementary data may be acquired by both methods.

Evidence of preoperative reduction in function of both kidneys when of moderate degree, is not a contraindication to operation. Excretion of phenolsulphonphthalein may be subnormal owing to inadequate excretion rather than to inadequate secretion. Moderate elevation of the value for blood urea may be caused by temporary ureteral obstruction, from stone, stricture, or edema of tissues, and function may be restored by operation or by ureteral catheterization. Following transplantation, the value for blood urea may be elevated, if both kidneys are involved, or if there is temporary obstruction with solitary kidney. As long as one kidney is functioning normally, however, there is usually no change in the value for blood urea, even though the function of the other kidney is destroyed. Moderate elevation of the value for blood urea may persist for some time after operation, or the value may fluctuate, but as a rule it gradually subsides as normal renal drainage is established. Persistent elevation of this value after operation may not cause any subjective symptoms. That renal function should be impaired as a result of absorption of urine retained in the bowel is not substantiated by our clinical experience. The delay in return of normal renal function after ureteral reimplantation may be reflected in intravenous urograms made shortly after operation. Visualization of the renal pelvis may be dim at first, but subsequently may become normal on one or both sides.

Preoperative visualization of a large hydronephrotic sac on one side would usually constitute a contraindication to transplantation of the ureter on that side. However, if the ureter only is dilated, and the renal pelvis is normal or dilated but little, transplantation may still be advisa-

ble. The etiologic factors involved in bringing about ureterectasis in these cases are of interest. In 1912 one of us (Braasch) showed that continued infection of the ureter is usually followed by cicatricial changes in the ureteral wall and consequent ureterectasis, without any obstruction being present. Such ureteral infection is often ascending, and is the result of, or is accompanied by, incompetence of the ureterovesical protecting mechanism. Etiologic factors favorable to ascending ureteral infection are certainly present with exstrophy of the bladder, and still it is surprising to observe how often the entire ureter remains normal, even when the patient is an adult. It is also surprising how uncommon is actual stricture of the ureter.

Renal lithiasis is occasionally observed as a complication. In several cases, extensive unilateral nephrolithiasis was present with secondary infection, requiring preliminary nephrectomy. A single stone in the renal pelvis or ureter was noted in several cases. In two cases in which there was extensive bilateral nephrolithiasis the infecting organism was found to be Proteus ammoniae. The stones were composed of calcium phosphate, were comparatively soft, and were similar in structure to those observed in the presence of the incrustations in the bladder that often are caused by Proteus ammoniae. It is advisable to treat such renal complications before considering ureteral reimplantation. Renal infection is a large factor in the success of the operation. If it is not dependent on faulty ureteral drainage, it will usually subside. When it does not, and in case infection is recurrent, treatment with the ketogenic diet and acidification of the urine should be tried. These measures might also be employed as prophylaxis prior to operation in some cases.

SUMMARY

The treatment of exstrophy of the bladder and complete epispadias, with total urinary incontinence, is best carried out by transplantation of the ureters to the rectosigmoid. It has been equally well established for treatment of large vesicovaginal fistulas and of other lesions of the bladder and urethra that cause incontinence of urine, if plastic methods of closure cannot be applied. In 85 cases of exstrophy of the bladder and total epispadias with complete incontinence encountered at The Mayo Clinic, the ureters have been transplanted to the rectosigmoid in separate stages, without the use of tubes or catheters. The right ureter has been transplanted first, and the left, ten to fourteen days later, if the patient's condition has permitted.

In a series of 25 cases in which one of us (Walters) operated, one death occurred. A comparison of morbidity in hospital, of the cases in which the ureters are transplanted one at a time, with that in the cases in which the ureters are transplanted simultaneously, would indicate that there is very little difference. Intravenous urography in most of our recent cases has revealed that when the ureters are accurately transplanted by the Coffey submucous method, without use of catheters, or tubes, little dilatation of the pelves, calices, or ureters has occurred. The urine is held by a competent anal sphincter for an average of two to four hours during the day and three to five hours during the night. Plastic operations on the penis, restoring the contour to normal, are advisable and can be carried out at the time of cystectomy. The aseptic suture method of anastomosis, recently offered by Coffey, does not seem to us to be as useful as the method of submucous transplantation he first presented.

In a series of 42 cases of exstrophy of the bladder, operation was postponed or not recommended.

Intravenous urography and the usual methods of estimating renal function give valuable preoperative information.

DISCUSSION

Dr. T. J. Kirwin: While Dr. Braasch and Dr. Walters have dealt largely with the practi-

cal and clinical side of ureteral implantation, I shall confine my remarks to the aspect with which I am most familiar, that is, the experimental side.

The historical aspect of this question is so fascinating that I regret it has no place in a discussion such as this. But I cannot refrain from saying that had Thomas Smith, in 1878, had the same diagnostic aids which are available today, I am quite sure he would not have proceeded with the second stage of his operation. Roentgenograms, neo-iopax and skiodan would have shown him the destruction of the kidney following the first implantation, and prevented him from attempting the second, thus avoiding the inevitably fatal outcome. Handicapped in the same way was Maydl, who was the first to conceive the idea of transplanting the entire ureteral orifice. As were Bergenhem, Pozza and Peters—a Swede, an Italian, and a Canadian who, quite independently and at opposite corners of the world, devised the plan of taking rosettes of trigone about each ureteral orifice and transplanting these to the bowel wall. The general health of the patient and his ability to control the urine in the rectum by the anal sphincter, were the only criteria by which they could judge the state of the urinary tract at any time after the operation had been performed.

The value of experimental work is generally measured only in terms of its practical application to problems in human pathology. But in the case of ureteral implantation, even if no practical results are obtained there is distinct surgical value in a realization of the tremendous difficulties which must be overcome, and the ability to appreciate the magnitude of any accomplishments such as Doctors Braasch and Walters have so modestly placed before us.

The results of our experiments on dogs have been much the same as those obtained by Franklin H. Martin at the beginning of the century, or those which Charles Morgan McKenna described in a personal communication received only a short time ago. Dr. McKenna said that even in his most successful experimental cases, in dogs living for more than two years after the ureteral implantation had been done, autopsy showed that despite apparent good health as soon as they had recovered from the effects of the operation hydronephrosis, ureteral dilatation and other evidences of urinary retention and stagnation were present. This had taken place quite irrespective of the absence or presence of stricture at the site of anastomosis. We are in agreement with the findings of Martin that the horizontal position of the dog does not provide as effectual drainage as does the upright posture of the human being. Were it economically possible to use chimpanzees for experimental ureteral implantation, we might have more satisfactory results.

Experimental work upon dogs has, however, shown that the surgeon *can* divert the urinary stream of the mammal so that it artificially reproduces the condition natural to bird and reptile. Birds have no bladders, and even in the few reptiles possessing a reservoir for the urine, the liquid and solid wastes of digestion are emptied into a common cloaca, and eliminated from the body by way of a single orifice. But to effect this alteration the surgeon must cut the ureter from its normal insertion in the bladder wall. This cutting injures the medullated and non-medullated fibers and ganglion cells of the ureteral nerve supply, upon which ureteral peristalsis depends. No matter how successful the anastomosis of the muscle tissue, its innervation will never again be perfect, and ureteral peristalsis will be more or less inhibited.

Extensive observation and experimentation on the physiology of the traumatized ureter were reported by Alksne early in the century, and by Gouverneur some ten years ago. They both determined that peristalsis is never resumed *across* the site of injury. Peristaltic waves were seen to originate at both vesical and pelvic ends, and to progress in either direction to the point of anastomosis. But there they halted. Urine was passed down from the kidney pelvis to that point and there accumulated. When enough had gathered to spill over the strictured area, gravity permitted it to run down the remainder of the distance to the bladder.

This explains why cystoscopic observation showed that the urine entered the bladder in a slow trickle, instead of by vigorous spurts intermittently, as is the normal manner. The human subject of implantation has the advantage over the experimental animal because his upright position favors this trickling out when but a small accumulation of urine has taken place.

In the experimental work upon which I have been engaged, no matter what the method used, the majority of the dogs showed when examined postmortem, evidences of urinary tract infection, hydronephrosis and ureteral dilatation.

When we can avoid trauma to the entire circumference of the ureter we will have done much to advance the success of this operation. A recent communication from Dr. William E. Lower is of especial interest in this regard. Dr. Lower passes a catheter into each ureter, and thereafter attaches the ureters to the sigmoid by a single stitch drawn very tightly, implanting both ureters at one time. After about five days, the stitches slough through, putting the ureters into communication with the bowel without directly traumatizing them. Nevertheless, the ureters must eventually be cut away from the bladder so that interruption to peristalsis must at some time take place.

In the interpretation of pyelograms much depends upon the individual viewpoint. What we at the Brady Foundation consider normal may not be quite the opinion of another clinic. On the other hand, what we look upon as a distinct dilatation may appear normal to an equally experienced observer elsewhere.

In conclusion: The operation of ureteral implantation as practiced by Dr. Coffey, Dr. C. H. Mayo, and his associates Doctors Walters and Braasch is a highly valuable one to all those unfortunates who are able to avail themselves of the great technical skill of these master surgeons. But where such skill cannot be commanded, or in those patients for whom shock must be avoided at any cost, the procedure of cutaneous ureterostomy is still available. This can be done extraperitoneally with practically no shock, even by those who have not had the long special training required for implantation into the sigmoid. But *for* all those who are able to undergo the implantation procedure, control of the urine by the anal sphincter offers the greatest opportunity of continuation of life under approximately normal conditions and circumstances which are acceptable to society.

Dr. C. H. Neuswanger: About two years ago Dr. Vermooten and I started out with the idea of re-implanting ureters into the bladder by a new method, hoping to use for these re-implantations dilated ureters. We proceeded to get dilated ureters by following a technique described by Gruber, in which he did a meatotomy and found that a few weeks after the ureteral orifice was incised dilatation developed. We accordingly operated on 9 healthy dogs, excising the right ureteral opening and incising the left. A few weeks later roentgenograms and cystoscopy showed that the hydroureters had failed to develop. On the other hand, we found the valves in all these cases were incompetent.

Our work did not confirm Gruber's, but it did confirm that of Draper and Braasch in that ureteral orifices might be incised and regurgitation follow, but not dilatation. We concluded, as they had, that meatotomy in the human being is quite safe and without ill effects, and probably results in regurgitation of urine up the ureter.

In one case where the right ureteral opening was excised and the left incised the animal showed regurgitation over a period of nine months, but no dilatation developed, as described by Gruber. Although we failed to obtain the results we expected, our animals afforded us an opportunity to study the function of the ureterovesical valve, and I believe this has an important bearing upon the transplantation of the ureters into the rectum.

We observed two things from our animal experiments: First, that an incompetent valve alone will not result in dilatation of the ureter, and second, that the regurgitation of urine, even though it contains infection, will not always lead to dilatation of the ureter.

The main point of my discussion is that perhaps the results observed in these animals have some bearing on the results in clinical cases. We believe that in animals with normal ureters in good condition you can expect favorable results by transplanting into the rectum or bladder. If one transplants a ureter which is infected or predisposed to infection (such as is found in an elderly person with carcinoma of the bladder) the results may not be good. If one transplants a ureter that is uninfected and particularly in a young person, the result should be better.

Dr. V. Vermooten: Since my experience with ureteral transplantation, outside of experimental work, has been limited to patients with extensive bladder tumors, I shall not enter into the clinical aspects of the discussion. But I would like to go on record as fully

appreciative of the excellent result that Doctors Walters and Braasch have obtained as is evidenced by the large number of normal kidneys and ureters, and by the duration of the lives of their patients after transplantation.

Their operation is a two-stage procedure. I believe this is one of the factors that contributes to their low mortality.

Dr. Kirwin's report covering three years of work showed that eventually most dogs died from infected kidneys. My present observations are confined to the results obtained from two weeks to two months after operation. The first and greatest essential is to have at least 3 cm. to 4 cm. of ureter within the lumen of the rectum, for the reason that in our dogs about 30 per cent had complete occlusion of the ureter due to the fact that it had retracted into the rectal wall. A second 30 per cent had retraction right up to the point where the ureter was to emerge through the rectal mucosa. This resulted in hydronephroses, infected ureters, and pyonephroses due to stricture at the point where the ureter enters the rectal lumen. In the remainder a narrowing of the ureteral lumen was also noted at this point in spite of the fact that a certain amount of the ureter (an ureteral bud) projected within the rectal lumen. On microscopic study we were impressed with the fact that the distal end of the ureter which was within the lumen of the rectum was very heavily infected. This narrowing of the lumen probably accounts for the ureteral dilatation. Even the part of the ureter within the rectal wall was dilated. A probe could be passed down the ureter to its entrance into the rectum where it met an obstruction, probably due to congestion and swelling of the part of the ureter that lies within the rectal lumen. Therefore the Mayo principle of transplanting one ureter at a time gives an opportunity for the piece of ureter within the rectal lumen to slough off and make good anastomosis, or for the edema to subside and permit good drainage, with subsequent subsidence of the hydronephrosis and ureteral dilatation.

In those cases in which catheters are used, the entire piece of ureter within the rectal lumen naturally comes away with the catheter when it is removed.

A few words about the formation of a valve at the site of transplantation. In animal experimentation, before Dr. Coffey introduced his "physiologic transplantation," practically all animals (about 80 per cent) died from peritonitis. Then Coffey advanced the theory of forming an ureterorectal valve, and immediately we began to get good results. Recently, however, I have transplanted quite a number of ureters straight into the bowel without any attempt at making a valve, and have been getting good anastomoses. The results are in no way different from those obtained with the various Coffey techniques. A submucous transplantation, then, is an excellent way of preventing fecal leak with subsequent peritonitis.

Clamping the rectum above and below the site of the transplantation and then distending it with 20 per cent sodium iodide, we actually got regurgitation of the opaque medium, as shown by radiographic examination in one dog out of seven. In this dog, 3 cm. of the ureter lay within the rectal wall.

I believe that recently Dr. Mann and his associates have described a simple technique for direct ureteral transplantation, and claim that the animals live for quite a number of years. This bears out the impression that only when the ureter itself becomes infected or obstructed does it become dilated; the actual valve action being of little importance in this regard.

In connection with Dr. Kirwin's statement in regard to cutting the ureteral nerves when the ureter is divided, and the influence of this on ureteral peristalsis and dilatation, we have to consider Wharton's observations on denervation of the lower ureter.

I feel that infection plays a more important rôle than it has been credited with. At the present time the actual technique of transplanting ureters has been practically perfected. The most important thing now is to devise some way of minimizing or preventing infection. That an ascending infection up the ureter from the site of the transplant does take place is shown by the presence of peri-ureteral infection in four of our dogs, by microscopic abscesses in the muscular wall of the ureter in one dog, and that in practically all there was infection in the tunica propria of the mucosa and even in the kidney pelvis. Dr. Coffey's newest method is apparently a very excellent one, and in our animals I have transplanted three ureters in this way. At autopsy, we found that the suture had not sloughed through

in one case; in another, the suture, cutting through the rectum alone, was responsible for a fecal leak and so death due to peritonitis. In the third case, I placed the sloughing suture longitudinally in the ureter so that a fistula of at least 1 cm. would result. Two months later, when the animal was sacrificed, there was no infection or dilatation of the ureter nor of the kidney. The fistula, however, was only 3 mm. in length. In 1851, Sir John Simon did much the same operation, and the patient lived for a year afterwards, during which time all the urine was passed per rectum.

I hesitate to mention my two-stage technique for total cystectomy, chiefly because it increases the number of operative procedures. It is at times worth while, though, as it minimizes considerably the suppuration following total cystectomy when the bladder is very heavily infected. It is therefore an operation particularly useful in dealing with tumors of the bladder. I remember a case I was called to see, in which a malignant papilloma had been excised some six months before. Cystoscopically the vesical cavity seemed to be one solid mass of papillomatous growth. The patient had urinary frequency of once every few minutes. There was considerable infection, bleeding and strangury. I advised transplantation of the ureters. I used the Furniss modification of the Coffey technique with satisfactory results as far as clinical evidence is concerned, but he does have bilateral hydronephroses. He empties his rectum every four hours during the day, and so is able to do his full day's work in the factory. He sleeps eight or ten hours without emptying the rectum. Recently, a phenosulphonaphthalein test of rectal accumulations showed 30 per cent excretion in the first hour, 10 per cent in the second. I hesitated to take out his bladder because he was doing so well. About nine months after the transplantation, he complained of considerable pain when at frequent intervals he ejected bloody fluid through his urethra. I advised radium or deep roentgenographic radiation, but he had previously had treatment along this line which caused so much rectal irritation that he refused. Knowing that the bladder was very much infected and full of tumor, and not wanting to risk the extensive infection which might follow operation, the ideal procedure seemed to be one similar to that used in excising diverticula of the esophagus.

Under general anesthesia, the bladder was exposed, dissected entirely free from the adherent peritoneum and surrounding tissues. The torn peritoneum was then closed, a rubber dam put around the freed bladder, the abdominal wound closed and the patient returned to the ward. There was little, if any, reaction to the operation. The next day, the patient's temperature went as high as 100°F. but he felt perfectly well. At the end of the week it was easy to re-open the wound under a general anesthetic. The torn areas in the peritoneum which had been sutured were completely sealed off, and without much difficulty the urethra was located and divided, removing the papilloma which had grown down into it. The bladder was then readily removed. A drain was placed in the cavity to take care of the dead space and accumulation of serum. The patient made a remarkable recovery. His temperature never went above 100°F. Two weeks later, he left the hospital perfectly well and his wound entirely healed. That was six months ago and the patient is still completely well.

Dr. A. R. Stevens: This report from the Mayo Clinic of a large group of cases of a relatively uncommon ailment, offers much encouragement to those of us who have been using the same method of treatment, though necessarily in very few instances.

The attempts at plastic repair of the open bladder and construction of a sphincter have usually led exstrophy patients through a long succession of operations for little or no gain. Procedures aimed at the substitution of the rectum for the bladder as a container for urine have offered these patients greatest relief, and the resulting benefit is quickly obtained. The justification of this operation depends not only on the comfort gained by the patient, but on whether the prospects of life are comparable to those of the patient without operation. The paper we have just listened to would seem to indicate that the subsequent prospects of life fully warrant this treatment. Statistics show that in but 30 per cent of exstrophy cases, unoperated upon, the patients reach the twentieth year.

I have been particularly interested to learn that the Mayo Clinic continues to implant the ureters in the bowel without using an indwelling ureteral catheter. I employed the catheter in but one ureter of one case. But the possibilities

of harm which may follow this technique have impressed me; and moreover I have had no occasion to regret the use of the earlier method of Coffey—implantation without a catheter. In every case I have found some urine in the rectum within twelve to fifteen hours after operation, and an abundant output the next twenty-four hours.

My limited experience has not led me to feel the need of a catheter even with moderately dilated ureters. In two patients who had had earlier nephrectomy for tuberculosis, the remaining dilated ureters were transplanted successfully. One of these was 1.5 cm. in diameter before it was cut across and relieved of its urine content. These patients were living and had perfect urinary control when last seen, two and three and one-half years after operation.

I have had the opportunity of operating upon only two patients with exstrophy of the bladder. The first case was a boy, sixteen years of age when he was operated upon, twenty-two years ago. Both ureters were placed in the rectum at one time, extraperitoneally, by the method of Bergenham. There were signs of infection of both kidneys at some time during the first few years after operation, but the general health has remained good to date. The phenolsulphonaphthalein output in two hours was 35 per cent one year ago. The control is perfect; the patient empties his rectum every three to five hours by day, and not over once at night.

The second exstrophy case, a man twenty-two years old, had had about twelve plastic operations by several surgeons, with little or no benefit. I transplanted his ureters to the sigmoid in two operations, by Coffey's technique (without ureteral catheters) over a year ago. The first operation was through a midline incision, and the second through a left oblique abdominal incision. There was evisceration through the midline incision four days after the first operation, following prolonged hard coughing, and again seven weeks later. He remains well with good urinary control.

Of the other individuals whose ureters I have transplanted to the bowel, but two were operated upon because of complete incontinence. A man forty-nine years old who suffered from incontinence following multiple perineal operations for strictures and infection, had his ureters transplanted by Coffey's earlier technique at two operations three weeks apart. He was at work, with good renal function and good urinary control, when last seen, over five years after operation. A woman twenty-eight years old with inoperable vesicovaginal fistula had both ureters implanted in the bowel at one operation (with no catheter used in either ureter). She had a particularly easy convalescence, and was comfortable when last seen five months after operation.

Dr. J. Sturdivant Read: My associate, Dr. F. L. Senger, and myself have performed a simultaneous transplantation of both ureters by the Coffey method in 9 cases.

The first, a man of fifty-eight years with dribbling due to destruction of the external sphincter, was operated upon under spinal anesthesia; duration of operation, two and one-half hours. The smooth convalescence and perfect functional control in a feeble looking man with chronic pulmonary tuberculosis taught me that the operation per se was no more shocking than other major procedures. This man died three years later, and the autopsy specimen here presented shows what a good valve nature formed at the site of implantation, and that the kidneys are undamaged except for stone in the lower pole of one, which follow-up by roentgenogram indicates formed during his last year of life.

A second man of sixty years with a similar condition of dribbling died sixteen days after operation. As there were large calculi in each kidney, the uremic death was not surprising.

The third case, a male of forty-three years, under general anesthesia (because spinal failed) showed little shock from a double transplant, so that a month later a partial cystectomy for carcinoma could be carried out successfully.

A fourth case, a woman of fifty, under spinal anesthesia seemed to stand a double transplant with no immediate signs of shock, yet on the seventh day died. Autopsy showed "bilateral ascending pyelonephritis." The surgical picture was that of peritonitis. In transferring the body to the morgue, both catheters were dislodged, so that it was not possible to determine what had happened to the transplants.

The fifth case, a child of six years with an epispadias not cured by three operative attempts elsewhere, made a smooth operative recovery from a simultaneous transplantation. Examination three years later showed perfect control and healthy urine.

In the sixth case, that of a very vigorous child

of sixteen months with a bladder exstrophy, only forty minutes were required to do a double implantation. The kidneys secreted well, yet on the seventh day death ensued, seemingly due to sheer cardiac exhaustion, as the autopsy states: "There is no general peritonitis; large intestine and pelvis are free from infection, and the kidneys show no infection."

Three other somewhat similar cases can be added for statistical purposes, so that one can speak of a 33 per cent mortality. Compare this with Dr. Walter's 24 cases in the past seven years, only one of which terminated fatally, and certainly the danger of a one-step procedure as compared with the two-step operation used by Dr. Walters is apparent, even after discounting his superior skill.

I should like to ask Dr. Braasch whether, at the time of the second procedure, he has been troubled with interference due to adhesions from the first operation.

That 76 cases have been done without the use of tubes or catheters will embolden us to discard these clumsy foreign bodies. One gains impressions from an analysis of a few cases, but a definite advance in knowledge is secured by the gathering of facts in a large series of cases; and when they are presented by trained and just minds, they are pearls without price. It was Doctor Oliver Wendel Holmes who, in an address to his students ninety years ago, said, "You have good cause to be thankful that you were born in the period of medical statistics which furnishes us the means of extracting collective results of a mass of individual facts too long to be analyzed by the unaided memory."

Thanks to Dr. Braasch's able presentation, I am persuaded for the present that the two-step procedure is much safer in children, and that these operations may be done without the use of catheters.

Dr. H. D. Furniss: I think those of William Lown are the only results I am familiar with which anywhere near equal the marked success of Doctors Braasch and Walters. They have been fortunate in getting favorable cases. Many patients who come to us have ureters infected and dilated.

I think in carcinoma cases, where intravenous urography shows marked dilatation of both kidneys and we cannot drain from below, they should be drained by nephrotomy before implantation, for two reasons: One is to get rid of the infection; the other, of the dilatation, to make the technique simpler and less dangerous. I have in mind two experiences with carcinoma cases in which the ureters were very large. In one case I was able to transplant both ureters at one time. I got off well as far as the ureters were concerned, but the patient died of renal insufficiency ten days later. The other developed rectal leakage and died of peritonitis five days afterwards. If we had been dealing with normal ureters, I believe the results would have been better.

I favor the Coffey technique, but disagree on the size of the catheters. He recommends a No. 10 or 11, which I believe is apt to cause necrosis. A No. 8 or 9 accomplishes the same purpose and is safer. If this catheter is used as a splint in the ureter and through the rectum for eight or nine days, better results are obtained. In short, I would like to put in a good word for the use of the catheter, but go on record against the use of catheters so large that they are likely to develop pressure necrosis in the ureteral walls.

Dr. B. S. Barringer: In discussing Dr. Braasch's very able and epoch-making paper one must manifestly differentiate between ureteral implantation as done in cases of exstrophy and similar conditions, and those preliminary to bladder resection for carcinoma. This gives rise to many questions.

Every patient with a bladder carcinoma is a poor risk for total cystectomy. The bladder is almost always infected, and often there is a secondary infection of the kidneys. The question arises whether such an extensive operation ought to be attempted without definite assurance of a cure. There is considerable leaning towards implantation and total cystectomy of the bladder today. So much so that Scholl has suggested that it is possibly the only way of approach for all bladder carcinomata. Yet Coffey presents only very few successful cases so operated upon. Scholl says that neither radium nor partial cystectomy ever succeed. It will take many more years of experiment to solve this moot question with complete satisfaction.

I should like to report one case in which radium implantation succeeded in spite of the fact that cystectomy with ureteral implantation was apparently the only surgical operation which held any chance of success. This case came under a Boston surgeon's care, one who

was an adherent of total cystectomy and ureteral implantation. He cystoscoped the patient, got a specimen for pathological examination, and did a suprapubic operation. He looked at the tumor, felt of it, opened the peritoneum and saw that there were no metastatic nodes. He believed the only thing he could do was total cystectomy. Because the patient was a poor operative risk, he sent her to me for radium implants. We found only a moderately malignant tumor (grade 2, radium sensitive) 4 by 6 cm., occupying the trigone and adjacent areas. She received 50 gold seeds of moderate strength (1.5 millecuries each). She had a mild convalescence, the temperature never going above 101°F., and that only for two days. Six months later the bladder was free from tumor. Two months later, because of a right pyelonephritis, I did a cystoscopy and found only one kidney which was hydronephrotic, with the ureter very much convoluted and dilated. The kidney was of poor function. Methylene blue was excreted late and of poor intensity. The inference was that it was probably an old condition dating back a number of years. I was not aware of this before the radium implantation. I am quite sure that if I had seen the skiodan picture before operation I would have hesitated to implant radium. One swallow, however, does not make a summer; and one case does not prove anything. It makes us wonder, though, about the advisability of ureteral implantation and total cystectomy in late cases.

Dr. William F. Braasch (*Closing*): It certainly is very interesting that following the transplantation of the first ureter we frequently note fever and evidence of renal infection which clears up in several days, but when the second ureter is transplanted there is usually very slight fever, if any. The inference is that the patient develops resistance following the first operation. As I mentioned before, we have been using recently ketogenic diet with acidification of the urine both before and after operation, with apparently much less evidence of urinary infection.

The cause of ureterectasis offers a very interesting problem. In some cases, as in the specimen just shown by Dr. Read, the ureter lumen is wide open throughout, and yet the ureter is dilated. Ureterectasis may be due to obstruction, infection, and disturbance of innervation or circulation. When it appears immediately following transplantation it may be due to temporary edema and constriction of the lower ureter. Ureterectasis has frequently been noted as the result of infection with cicatricial changes in the wall of the ureter. Beach has demonstrated that ureterectasis may follow manipulation of the ureter, apparently as the result of disturbance to either innervation or circulation.

Careful anastomosis is undoubtedly a very important factor in the successful transplantation of a ureter. A very interesting suggestion has been made by Dr. Vermooten, that the value of submucosal implantation of the ureter may lie in the prevention of peritonitis and ureteritis rather than in its valvular action. I do not believe this is entirely correct, but it may be an important factor.

The question of adhesions found on operating on the second ureter has been raised by Dr. Read. Dr. Walters has never observed any difficulty from adhesions. When the anastomosis is completed on one side, adhesions to the lateral peritoneum are formed which do not in any way interfere with subsequent anastomosis on the other side.

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SOLITARY CYSTS OF THE KIDNEY

A REVIEW OF CO-EXISTING PATHOLOGY*

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SOLITARY cysts of the kidney have been, and still are a subject of marked interest and controversy. The theories of formation, the etiology, the incidence, the *x*-ray findings, co-existing pathological conditions, and the methods of preoperative diagnosis have incited the publication in the last few years of an unusually large number of papers. It is the purpose of this paper to review the literature, especially the more recent articles, and to report 10 proved cases of solitary cyst of the kidney.

The type of solitary cyst under discussion is described as a voluminous, non-parasitic single, usually unilateral cyst containing serous fluid and growing in a kidney that is otherwise normal or only slightly altered. It originates in the renal cortex with which it is continuous. It is not connected with the pelvis. It is slow in development and runs a benign course. Occasionally two or three cysts are found in the same kidney, or bilaterally. The cystic fluid in some cases may be hemorrhagic. Some renal cysts are a few millimeters in size, while others are as large as a fetal head.

In 1850 Hare reported the first operative case of solitary cyst. The tumor was found in a male, aged sixty-two, and was situated in the lower pole of the right kidney. Lancereaux and Siredly, in 1858, reported the first case in the French literature, and Czerny, 1886, was the first in the German literature to report a case. Ladinski, Boldt, and Krusen, in 1906, were early contributors to the American literature. For a history and discussion of the early theories of solitary cysts, Caulk's paper is very exhaustive and complete.

Among the more recent papers of especial interest are those of Carson, Cunningham and especially Hepler. Carson has summed up the three most popular present-day theories as follows:

1. Solitary cysts are due to embryonal rests.

2. They are due to failure of union between the glomeruli and collecting tubules.

3. They are retention cysts due to blocking of the tubules by fibrous tissue or blocking of the glomerular tubules by desquamated or degenerated cells with continued secretion of urine.

Cunningham's theory is similar to the third.

Heplar criticises the first of the two foregoing theories by calling attention to the fact that in children the cysts are rare both clinically and at autopsy. It is hard to reconcile these facts with a theory assuming that solitary cysts start early in life. However, this line of reasoning is applied to the theories of the etiology of hypernephroma and congenital cystic kidneys. Hepler also claims that Cunningham's theory may explain the origin of small retention cysts of nephritis, but he considers it an inadequate explanation of the larger cysts, for the following three reasons:

1. There is no evidence of any obstructive factor in many cases.

2. Though pathological lesions blocking large groups of tubules are common, solitary cysts are comparatively rare.

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3. Obstruction to the tubules in the papillae has been produced experimentally, without producing cysts. In some instances slight dilated areas were formed.

Thus, Hepler concludes that group tubular obstruction alone cannot cause these dilatations. Hepler cites experiments done in Hinman's clinic, on rabbits, whereby solitary cysts of the kidney were produced by blocking a group of tubules in a small area, by simultaneously fulgurating and ligating the posterior branch of the renal artery. An infarct was thus produced and in some instances repeated hemorrhages into the area. After about eighteen days these areas assumed the appearance of solitary cysts. Hepler concludes from these experiments:

1. Large solitary cysts of the kidney are acquired.

2. They are not a distinct entity with a common etiology.

3. They are caused by pathological conditions of the kidney when so situated as to produce a combination of group tubule obstruction and anemic degeneration of the parenchyma from circulatory disturbances in that segment of the kidney.

Among the clinical and pathological features of large renal cysts which lend support to this hypothesis are:

1. The average age incidence of forty-five years, a period when vascular lesions such as arteriosclerosis, endarteritis, aneurysms, infarcts, and other acquired lesions, such as tumors, are common.

2. The rather frequent association of these cysts with lesions which might produce the conditions assumed to be necessary for their formation.

3. Frequently, together with the so-called solitary cyst, one finds in the kidney a number of smaller cysts similar to the large one in every detail, except size.

Hepler's theory and his experimental work is very convincing. However, Latteri reported experiments on dogs in which he produced solitary renal cysts by implanting fragments of the ureter or renal pelvis in the kidney parenchyma. He concluded that renal cysts were congenital in origin and developed from fragments of the ureter or renal pelvis which were displaced into kidney cortex during the process of embryological development. A uniform etiology for these cysts has not been conclusively determined, for here are two careful workers who are able to produce solitary renal cysts by widely divergent methods.

The age incidence of solitary cysts varies. Magnini asserted that they never appeared before the eighteenth year, but Wagner reported a case in an infant four years old. In a very large surgical pediatric service, in Boston, over a period of about fifteen years, only 3 cases have been seen in children under the age of twelve. Hepler found the average age to be forty-five for serous cysts, and forty-eight for hemorrhagic cysts. Brin believed that in the period from thirty to fifty they are most frequent, and that the period from between fifty and sixty was second in frequency. Botto-Micca reported 5 cases in which the age incidence was between twenty-five to thirty-six years. In the 10 cases reported here the age ranges from forty-two to seventy-eight, with an average of fifty-six.

Women seem to be affected about twice as often as men, although in our series there are five of each sex. Brackel is quoted as connecting this increased incidence with pregnancy. Botto-Micca, who refutes this, states that the connection is contraindicated by the fact that females who have never had sexual intercourse, and males may be the victims of the disease. Carson's ratio was 89 females to 41 males; Hepler's was 163 to 79. At the Boston Lying-in Hospital out of 215 pyelograms taken during pregnancy and post partum not a single case of solitary cyst was observed or suspected.

The right kidney, according to reported cases, seems to be most frequently involved. Fullerton reported 44 on the right side to 38 on the left. Brin observed 21 cysts on the right side, and 14 on the left. However, in only 2 of our 10 cases was a cyst on the right side.

The lower pole is the site of most frequent occurrence. Brin observed 13 cysts in the lower pole, 12 in the upper, 2 in the convex margin, and 2 on the anterior surface. Harpster, reporting 95 cases collected from the literature, found 39 in the lower pole, 20 in the upper pole, 6 in the convex margin, 2 in horseshoe kidneys, and in 28 the site was not stated. Seven of our cases were in the upper pole, and three in the lower pole.

The symptoms of solitary renal cysts are at times vague. Often there are no symptoms. The growth of the cyst is slow and the surrounding organs have time to adjust themselves to the changes in pressure. This fact probably accounts for the high incidence of cysts incidentally found at autopsies. The symptoms vary somewhat with the size and situation of the cyst. Large cysts of the upper pole give rise to diaphragmatic pressure and irritation, and thus cause dyspnea, cough, and pain in the chest and shoulders. The symptoms of cysts of the lower poles are those of any retroperitoneal mass. Pressure on the intestines and stomach may cause gastrointestinal symptoms such as epigastric pain, vomiting, and loss of appetite. The mass may cause a feeling of weight and discomfort which is often relieved by an abdominal support, and aggravated by exertion. Pain is absent in the majority of cases, but when present, it is usually due to pressure of the cyst on the ureter, or ptosis of the kidney with a resulting hydronephrosis. It is surprising how large the tumor may become without pressing on the ureter. Hematuria, if present, incites the suspicion of a complicating factor, such as tumor, calculus, or nephritis.

The physical examination may be entirely negative. If the cyst is large, or the individual thin, there may be felt in the kidney region a mass which fluctuates and gives a dull note on percussion. Cysts of the lower pole can usually be palpated. Cysts of the upper pole are difficult to palpate. Pyelographic examination, except in those cases in which there is pressure of the cyst on the ureter, is usually negative, and it is only rarely that the kidney function is affected.

The diagnosis of solitary cysts by *x*-ray is difficult and has not been made as often as it is possible. The cysts may not cause a demonstrable change in the kidney outline, or compression of the pelvis and calyces. The pyelograms may appear normal. Pneumoradiography is to be avoided because of the danger of puncturing the cyst. This leads to dangerous complications. However, in the vast majority of cases, the diagnosis of at least a renal tumor can be made.

The important points in roentgen diagnosis are:

1. *The renal outline.* More attention should be paid to the kidney outline. With poor roentgenological technique, or in patients with marked obesity, or with gas in the bowel, the outline of the kidney is indistinct or absent. The cyst may produce on the ordinary roentgenogram, clubbing at the poles. Intravenous urography is a valuable procedure in the diagnosis of these cysts. The excretion of the urographic medium through the kidney increases the sharpness and density of the renal outline. Cysts of the lower pole are more often observed on the *x*-ray film than cysts of the upper pole. The shadows of the liver and spleen often mask the irregularity of the upper pole.

2. *The renal position and axis.* The growth of the cyst with pressure against adjacent organs changes the position of the kidney. A cyst of the upper pole may cause displacement of the kidney. Since these cysts grow from the cortex and may arise from the borders of the kidney, they occasionally cause rotation or deviation of the axis of the kidney.

3. *Deformities of pelvis and calyces.* The deformity depends not entirely on the size of the tumor but on its location in the kidney and especially its proximity to the pelvis and calyces. Thus, small cysts properly situated may cause marked deformities. Distortion is more likely to be

present if the cyst is in the upper pole or in the middle of the kidney. In cysts of the lower pole, the free space and the relaxability of the structure below the kidney permit downward growth and traction of the cyst away from the pelvis and calyces. The distortion when present consists of flattening, blunting, or disappearance of a calyx, or flattening of the pelvis, or both. The distortion usually follows the outline of the cyst.

4. *Deformity and compression of the ureter.* This is most often found in cysts of the lower pole. However, the cysts may reach tremendous size without demonstrable evidence of pressure on the ureter. The subsequent hydronephrosis unfortunately may obliterate or obscure the deformities of the pelvis and calyces. This is an important factor which often leads to errors in diagnosis.

5. *Pressure on adjacent organs.* In gastrointestinal roentgenography, the outline of a mass is sometimes seen pressing on the stomach or intestines. Grover reported a case in which the stomach was pushed to the right and the pyelographic studies showed only an ectopic kidney pushed down by some extrinsic cause. A 6½ lb. cyst was resected from the upper pole.

6. *Calcification of the cyst.* Where there are occasionally present calcified areas in the walls of the cyst, a shadow is produced on the *x*-ray plate.

Grossly, the typical renal cyst is round and smooth. The wall is thin and translucent and often contains large blood vessels. The cysts vary in size from an English walnut to a fetal head. However, they may reach an unusually large size. Morris reports one weighing 16 lb. Lockyer reports one which contained 25 pints of fluid. The lining of the cyst is glistening and greyish-white in color. Many distended vessels can be seen through the wall which varies in thickness, and may contain a few trabeculations. Occasionally, a number of subdivisions give the cyst a multilocular appearance. The cyst is very adherent to the kidney. It is almost impossible to strip it away, and it has to be sharply dissected.

Microscopically, the cyst wall consists largely of fibrous connective tissue. It connects with the interstitial tissue of the kidney parenchyma. There is another inner layer of connective tissue which contains the blood vessels. It may be lined by a layer of epithelial cells varying in shape from flat to cuboidal, but this is very often absent. The kidney tissue remains normal, except immediately adjacent to the cyst where there is sometimes evidence of pressure atrophy, and occasionally a low grade chronic inflammatory process. Calcified and cartilaginous areas in the cyst walls are occasionally visible. They measure up to 2 cm. in length, and are situated throughout the wall.

The contents of the cyst are usually serous and clear pale yellow. The fluid contains a small quantity of sodium chloride and has a high specific gravity. Following hemorrhages into the cyst, the serous fluid becomes red or brown and contains the blood elements. The hemorrhage probably comes from the large congested vessels found in the walls of the cyst. Hemorrhage terminating in death has been reported. Laquiere, according to Heuper, found secondary hemorrhage in 10 per cent of his cases.

Cholesterin is sometimes present. Fat droplets have been found in the fluid causing it to appear opaque and milky. Urea, uric acid, and glucose may be present in traces. Rokitansky was unable to find any urinary constituents or secretions in cyst fluid. However, in such instances where there is a connection between the cavity of the cyst and the pelvis of the kidney, the findings differ. Here, urea is found as well as other urinary constituents. This fact lends weight to the theory that the so-called cysts which connect with the renal pelvis are really diverticula.

Suppuration in a cyst is rare, according to Brin. Patel and Mallet-Guy reported a case in 1929. Sweester, in 1929, reported a case in a twenty-two year old person.

The cyst weighed 2 lb., was in the upper pole, and was not connected with calyces. The microscopic examination showed a nephritis, but no other cysts were present. The patient had previously shown a trace of pus in the urine. Was the pyelitis the source of the infection of the cyst? Desnos, in 1911, reported a large serous cyst of the lower pole of a tuberculous kidney. Rupture of the cyst is very rare. Simoncelli observed a spontaneous, and Lipskeroff a post-traumatic rupture. When fluid from the cyst penetrates the surrounding tissue, inflammation results.

The kidney which contains a solitary cyst may be the seat of other pathology. The kidney pelvis may contain calculi. Ainsworth, Davis and Dunhill, and E. R. Roberts reported a case each of solitary cyst with stones in the renal pelvis. Cunningham, in 1915, reported a case of cyst of the lower pole of the right kidney, which contained a carcinoma, situated above the hilum. E. G. Crabtree described a kidney containing a solitary hemorrhagic cyst and a sarcoma. Ritter removed a kidney from a woman of thirty-seven years, showing both a solitary cyst and a hypernephroma. Colston reported a case of papillary-cyst-adenoma, and solitary cyst occurring simultaneously in one kidney. A few small cysts, a few centimeters in length, were found with a large cyst. Occasionally, a solitary cyst is simulated by a cystic degeneration of a renal tumor. Therefore, a careful examination should be made of every kidney containing a cyst. In one of the kidneys of this series, in addition to the solitary cyst, there was found a hypernephroma invading the renal veins. The error that might have been made in this case was to explain all the signs and symptoms of the patient on the basis of the cyst, and fail to perform a nephrectomy.

Solitary serous cysts may be found in congenital anomalous kidneys. In 1910, Moynihan reported a cyst of the isthmus of a horseshoe kidney. In 1911, Bockenheimer reported the resection of a cyst of the right side of a horseshoe kidney which contained a stone in the pelvis and in which the left side was atrophic. The entire kidney was 2½ inches in length. Graves reported a solitary cyst containing 1400 c.c. of thin serous fluid in a congenital solitary kidney.

The earlier surgical treatment of solitary cysts consisted of puncturing and draining the cyst. However, this method was uncertain, inadequate, and of temporary benefit since the cysts soon refilled, and required repeated puncturing. The danger of infecting the contents, and forming a suppurative cyst is always imminent. Irritated substances were sometimes injected into the cysts in an attempt to obliterate them. According to Lejars, this method carried a 50 per cent mortality. For a time, simple incision of the cyst was practiced. Many of the cases thus treated were left with draining fistulae, and the procedure was abandoned.

Marsupialization, or partial excision of the cyst, and suturing of the edges to the abdominal wall was tried, and has been abandoned because of the large incidence of residual fistula. Tuffier reported an incidence of 2 out of 6 cases, and Morris 3 out of 5 cases.

The best results are obtained by complete excision of the cyst. However, this is very often difficult because of the fact that the wall of the cyst is not easily separated from the kidney tissue. The cyst does not shell out from its bed, and must be dissected away. A small amount of renal tissue is always removed. Many use a wedge-shaped incision. The bleeding surfaces are controlled by gauze pressure, and are brought into apposition by suturing. Resection of the cyst was first successfully carried out by Tuffier.

The technique we have followed has been to remove as much as possible of that part of the cyst which protruded beyond the surface of the kidney. A running hemostatic suture is placed in the kidney tissue along the cut edges of the cyst. A sponge is then packed tightly against the remain-

ing surface of the cyst. The sponge is removed in from seven to nine days postoperative. The results we have obtained

Fig. 1. Case 1. Arrow points to hypernephron invading renal tissue in upper pole.

were excellent. There has been neither sinus formation nor recurrence of the cyst.

In addition to performing nephrectomy in instances where other tumors are found with cysts, nephrectomy is also indicated in cases in which the cyst by pressure has destroyed the greater part of the kidney. Excision of the cyst in such cases will seriously interfere with the blood supply of the remaining tissue, since large renal vessels sometimes spread over the walls of the cyst. These anastomose freely with the vessels leading to the kidney proper. This complication is especially frequent when the cyst lies in the middle third of the kidney.

The prognosis is favorable. Cysts are benign in character, and, if properly removed, do not recur. The renal prognosis is guarded only by the degree of secondary complications offered by associated disease.

CASE REPORTS

Case 1. A. M., male, Jewish tailor, aged fifty-nine, entered the hospital complaining of pain in the right flank, of six days' duration, which radiated to the right lower quadrant and toward the pubic region. The physical examination revealed slight tenderness in the mid-epigastrium and right lower quadrant, and a palpable right kidney. A catheter specimen of the bladder urine showed on microscopic examination 50–150 red blood corpuscles, 0–3 white blood corpuscles, and no casts. The cystoscopic examination showed a slight cystitis. Both ureteral orifices were normal in position and appearance. A 5 French catheter met obstruction half way up the right ureter. There was practically no function from the right kidney. The renal function was excellent from the left kidney. The findings of the uretero-pyelographic examination on the right side were consistent with a cystic kidney, with a moderate degree of hydronephrosis. The right kidney appeared to be considerably enlarged, and there was an independent shadow, bean-shaped, in the lower pole of the right kidney, which extended to about one inch below the crest of the ilium. Uretero-pyelographic examination by intravenous method was done. The left kidney outline was visible, and appeared to be slightly enlarged. The renal pelvis was normal in appearance. The right kidney was poorly outlined. The pelvis and calyces could not be seen, which was probably due to disturbed renal function. The patient developed jaundice, and had an elevated icteric index. A right nephrectomy was done under spinal anesthesia. The pathological report was hypernephroma of the kidney with extension to the renal vein, solitary cyst of the lower pole of the kidney, and multiple cortical abscesses. Following the operation, the patient was discharged on the fifteenth postoperative day, clinically improved.

The pathological report was extremely interesting. The specimen consisted of a kidney which had a large cyst attached to the lower pole. The kidney measured 11 cm. long, and had an average width of about 5 cm. The cyst was 5 cm. in diameter, translucent, and

light amber in color. There was several small cysts about 0.5 cm. in diameter bulging from the outer surface of the kidney. The kidney was greyish-pink in color, and felt soft. The upper pole, however, was hemorrhagic, and was reddish-brown in color. There was one cavity which extended into the upper pole of the kidney on the posterior surface. This was 2 cm. in diameter, and had a mottled wall, in some portions being grey with linear white markings, with areas of hemorrhage between them. Along the lateral margin there was a bulging mass which measured 1.5 by 2 cm., and projected from the kidney for a distance of about 5 cm. It had a mottled coloring of yellow, pink, and black areas. It was soft and fluctuant. The kidney was then bisected. The renal tissue was brownish-yellow in color, and the cortex, which was not distinctly marked off from the pyramids, had a thickness of 0.5 cm.

The tumor area was soft, yellowish, hemorrhagic, 2 cm. in diameter, and was inclosed by a well-delineated white capsule. In one area the mass broke through the capsule and there were small nodules of similar appearance beyond its borders. Some small nodules composed of similar material were also clustered in the pelvis just below the large soft area. These small nodules were attached to a large plug which measured 1.5 cm. long, and filled the lumen of the vein and the pelvis. As branches of this vein were followed up towards the cortex, extensions from the soft yellowish plug were seen to extend into the ramifications of the vein. The cyst was not opened.

Microscopic sections of the kidney showed an infiltration of large, pale, polygonal cells, with invasion into the veins. The cells had a foamy hydropic cytoplasm, basophilic oval nuclei, sharp cellular outlines, and replaced large areas in the cortex. In several veins these cells plugged up the lumen. The renal tissue showed its usual markings and features, but there were quite a number of large collections of degenerated polymorphonuclear and red blood cells scattered in the renal tissue. The glomeruli and tubules were not affected, and showed no pathological changes.

The patient is still alive seven months after the operation. His jaundice has disappeared. If this man's kidney had not been carefully inspected and the necrotic areas found, a resection of the cyst rather than a nephrectomy would have been done. The patient, however, carries a poor prognosis due to the involvement of the renal veins by the hypernephroma. This case also presents a rare complication:

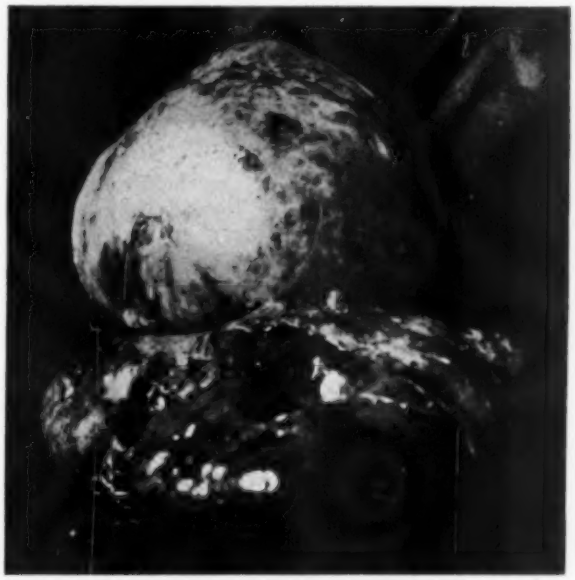

Fig. 2. Case 1. Arrow points to necrotic area for which nephrectomy was done rather than resection of cyst.

icterus, which was probably due to compression of the common bile duct, by a solitary cyst, since it cleared immediately after operation.

Case II. M. B., female housewife, aged forty-seven. Her present illness began five years ago with bladder trouble. She could not void when sitting and had to stand up and press on her abdomen very hard in order to empty her bladder. On physical examination, the abdomen revealed a tumor in the left upper quadrant which was rather fixed, did not move with respiration, and was the size of a grapefruit. A diagnosis of solitary cyst of the kidney was made. A left nephrectomy was done under ether anesthesia. The specimen consisted of the shell of the kidney with an enormous solitary cyst. The patient was discharged fourteen days postoperative. She made an uneventful convalescence. The kidney was 13 cm. long and 7 cm. in thickness. Attached to one lateral surface was a thin walled globular cyst measuring 15 by 15 by 10 cm. On the upper surface of the kidney was a small greyish nodule 1 cm. in diameter. On section, the nodule was soft and yellowish-grey in color. The ureter was of normal caliber, patent, and led in the pelvis. On section both kidney and pelvis were normal. The cyst was lined by a smooth pale membrane and was filled with clear serous fluid. The microscopic examination

of the small tumor showed a delicate reticulum enclosing large pale cells. No mitotic figures were found. The tumor was sharply circumscribed but showed a definite capsule only in part. The diagnosis was solitary cyst of the kidney and hypernephroma. There was no clinical evidence of the presence of this tumor until the kidney was cut in half. Subsequent examination of the microscopic sections by other pathologists failed to verify the diagnosis of hypernephroma. The exact nature of the tumor was not determined. We were unable to follow up this case.

Fig. 3. Case II. Arrow points to small tumor, nature of which was never determined.

Case III. J. A., male, Jewish, white, aged forty-nine, entered the hospital complaining of pain in the left lower quadrant. Five years before entry, the patient had a severe sharp pain in the lumbar region which extended to the left lower quadrant. The pain was relieved after a bowel movement. A few days before entry, he was taken with another similar attack. He also had pain on micturition for a number of months. The past history, family history, and marital history were irrelevant. The physical examination was essentially negative. The urine examination revealed a few leucocytes and a few red blood corpuscles in the bladder specimen. Cystoscopy and pyelography showed the bladder and urethra to be normal. After intravenous injection of phenolsulphonphthalein, the appearance time was three minutes from the right kidney. No color appeared from the left kidney. The pyelogram showed a dilated pelvis and ureter on the left. The pelvis was deformed at its lower calyx. There was a small shadow about the size of a split pea which probably represented a stone in the lower calyx. The left kidney was very much enlarged. The lower pole extended to about ½ inch below the level of the crest of the ilium and appeared to be club-shaped. The lower calyces were flat. The roentgen conclusions were that the mass at the lower pole of the left kidney was probably a cyst.

Fig. 4. Case IV. Arrow points to stone in lower calyx. Note hydronephrosis due to ptosis of kidney caused by cyst at upper pole.

On operation, a large cyst was found at the lower pole. A stone was felt in the left ureter about 2 inches from the bladder. The cyst was drained and excised, and the edges of the kidney tissue sutured together. The ureter was opened and the stone removed. The abdominal wall was closed in layers, and the wound was drained. The fluid from the cyst was straw-colored and contained a slight coagulum. There was 1½ per cent albumin. A few blood cells were present in the sediment.

The final diagnosis was solitary cyst of the left kidney and ureteral calculus. The patient made an uneventful recovery.

Case IV. B. S., white, Jewish, male, aged fifty-one, married. The patient entered the hospital complaining of pain in the left side. The *x*-ray examination showed the right kidney to be normal in size and position with no evidence of stones. The left kidney was tremendously enlarged practically filling the left side of the abdomen, its lower border lying about one inch below the level of the crest of the ilium. There were numerous large and small calcified bodies scattered throughout the lower portion of the kidney which had the characteristic appearance of multiple stones. The left ureter was markedly displaced to the right. The appearance of the kidney and scattered calcification was suggestive of a large cystic kidney with degeneration. The possibility of a neoplasm or a solitary cyst could not be ruled out. The diagnosis of a tumor of the left kidney was made. The urine and sediment of the bladder and kidney were negative. The non-protein nitrogen was 133 mg. per 100 c.c. of blood. The uric acid and creatinin in the blood were elevated. It was felt that evacuation of the cyst might relieve some of the symptoms of pressure. Under local anesthesia, the usual left kidney incision was made, and a large solitary cyst of the kidney was found and drained. Because of the poor condition of the patient, no further surgery was attempted. The wound drained quite profusely for a number of days, but the patient gradually improved His non-protein nitrogen dropped to 85 mg. per 100 c.c. of blood. The pathological examination of a section of the cyst wall showed chronic inflammatory tissue. The fluid from the kidney cyst was bloody and had a specific gravity of 1.020. No sugar was found. There was a very large amount of albumin. The sediment showed erythrocytes, leucocytes and degenerative cells. Cholesterol crystals were present. The Gram stain showed pus cells but no organisms. When the patient's condition improved, under a general anesthesia, the left kidney incision was reopened. At the upper pole of the kidney there was a rather large cyst. The cyst was resected. The renal pelvis was opened and a small stone removed. The kidney was replaced in its bed and the fascia and muscles of the abdomen were sutured in layers. The pathological examination revealed several small pieces of cyst wall with attached kidney tissue. The surface had an irregular outline and was not covered by epithelium. The wall was of fibrous connective tissue. The section showed marked fibrous connective tissue proliferation with marked injury to the kidney tubules. Practically all glomeruli were sclerosed. The epithelium of the tubules was cuboidal. The patient had a slow but uncomplicated convalescence and was well six months postoperative.

Fig. 5. Case VI. Note flattening of upper calyx due to pressure of cyst. This illustrated cause of distortion of pelvis seen on pyelographic plates.

Case V. H. A., white, married, male, Jewish, aged fifty-one, entered the hospital complaining of pain and a mass in the left side of the abdomen of ten months' duration. The pain was dull in character and localized to the lumbar region directly over the mass. There was no hematuria, dysuria or pyuria. He had nocturia five to six times. The past history, family and marital history were negative. The physical examination revealed a large solid mass extending from the left costal margin down to the iliac crest, practically filling that side of the abdomen. He had enjoyed good health up until three years ago

when he was suddenly taken with pain in the left quadrant which at first was colicky but soon became sharp and knife-like in pain in the right lower quadrant of one week's duration. This was accompanied by frequency and hematuria. The past history was essen-

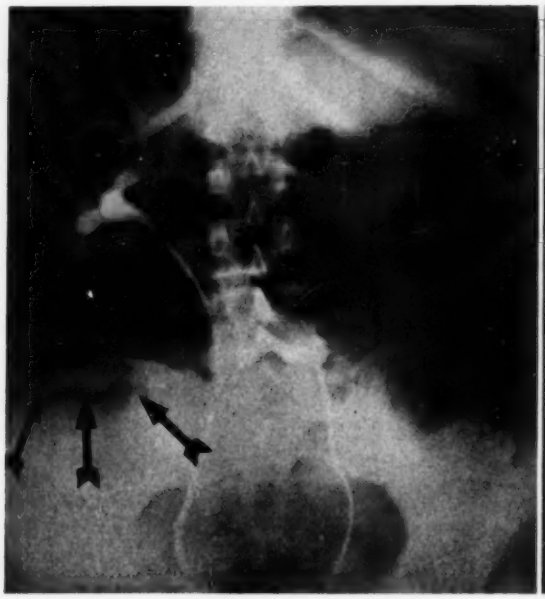

FIG. 6.

FIG. 7.

FIG. 6. Case VII. Note outline of cyst of lower pole, upper displacement of pelvis, outward rotation and displacement of kidney, and inward displacement of ureter.

FIG. 7. Case VIII. Note very definite outline of cyst on lower pole of flat kidney plate.

character, radiating from the umbilicus to the left lower quadrant, then across to the lumbar region of the back. He had had four attacks. For five months he had attacks of burning on micturition and noticed that his urine was red in color. This discoloration was periodic and usually remained for two days after onset. The physical examination was essentially negative except for the mass. A left pyelogram was made. The sediment of the left kidney showed a few crystals. The renal function of the left kidney was poor. The ureteropyelographic examination showed a mass bulging into a dilated left renal pelvis. The cystoscopic examination showed the bladder to be normal. In the region of the lower calyx of the left kidney there was a rounded shadow suggestive of a stone. The entire left ureter was somewhat dilated. The patient was operated on. A solitary cyst was found and resected. The cell count of the cystic fluid was polymorphonuclear leucocytes 83, lymphocytes 17. The patient made an uneventful recovery. A week after discharge, the patient had a coronary attack and died. No autopsy was obtained.

CASE VI. S. G., Jewish, female, aged forty-seven, entered the hospital complaining of tially negative. The physical examination was negative except for tenderness in the right costovertebral angle. A mass could be felt in the right side. A diagnosis of enlarged kidney, probably cystic, was made.

The pyelographic examination showed the right kidney to be markedly enlarged and rounded. The pelvis was pushed upwards and the calyces were thin and elongated, which suggested pressure from a large mass. The urine contained a few pus cells, and a slight trace of albumin. Under general anesthesia, through a right rectus muscle splitting incision, a nephrectomy was done. The kidney contained a large cyst about the size of a grapefruit growing posteriorly from the upper pole. The patient made an uneventful recovery, and was discharged twenty days postoperative. He is now in good health.

CASE VII. J. M., aged forty-eight, was admitted to the hospital for pain in both loins. Two years ago he was taken with an attack of pain in the right side, which continued for two days. About four months previous to admission, the symptoms recurred. On pyelography, a large left kidney was found with a compressed pelvis, blunted lower calyces, and

a clubbed lower pole. The urine examination was negative. The cystoscopic examination did not reveal any additional data. The

Fig. 8. Case x. Note downward displacement of renal hilum and compression on upper pole.

renal function of the right kidney was 15 per cent and of the left kidney was 12 per cent. The conclusions were that the clubbing of the lower calyx of the left kidney, clubbed lower pole and upward displacement of the pelvis was consistent with a solitary cyst of the kidney. The patient was operated on. A left loin incision was made and the kidney exposed. On the lower pole of the kidney, a large solitary cyst containing 200 c.c. of clear, amber-colored fluid was found. An incision into the cyst was made. The fluid was collected, the cyst trimmed to the edge of the kidney, and an over suture was used along its border for hemostasis. Very large dilated veins were found at the lower portion of the cyst adjoining the kidney. A cigarette drain was placed at the site of the cyst, and the abdominal wound closed in layers. The patient made an uneventful recovery.

Case viii. R. G., aged forty-three, female, Jewish housewife. Her chief complaint was frequency and dysuria, and slight pain in both

Fig. 9. Case x. Note structure of inferior of cyst especially trabeculations and dilated vessels.

loins. For many years the pain in both loins was accompanied by frequency, urgency, dysuria, and occasional nocturia. The kidneys were not palpable. The cystoscopic examination revealed a normal bladder. The pyelographic examination showed a large left kidney with definite pressure on the lower calyces and slight outward displacement of the pelvis which was strongly suggestive of tumor of the lower pole of the left kidney. The pyelogram of the right side was normal. Operation on the left side was performed, and revealed a cyst situated at the lower pole of the left kidney. The operation was done in a manner similar to the preceding case. The patient made an uneventful recovery. Two years postoperative there was no recurrence of symptoms.

Case ix. E. J. M., white, Irish, female, aged seventy-eight, entered the hospital complaining of vomiting of eight weeks' duration. She also had pain in the right upper quadrant which radiated from the epigastrium backwards and downwards. There were no urinary symptoms. The family history, past history, and marital history were essentially negative. There was a mass in the right lower quadrant reaching from the crest of the ilium almost up to the costal border. This was firm, smooth, hard, immobile, and could be clearly outlined.

The liver was not palpable. The kidneys were not felt. There was evidence of a marked loss of weight. *X*-ray examination revealed a large mass in the right upper quadrant and fluid in the chest. The barium enema showed a narrowing of the ascending portion of the colon which was suggestive of a lesion. Three thousand cubic centimeters of a chocolate-colored fluid were obtained after a thoracentesis on the right side. Eleven days after entering the hospital, the patient became drowsy, gradually went down hill and expired. At autopsy, the liver weighed 3220 gm. and presented a very striking appearance. It was white, bulging, shiny in appearance, tense, and fluctuating. Incision of the liver showed that the right lobe consisted of an independent cystic body, 7 cm. in diameter. The cyst contained 1500 c.c. of purple-greenish fluid which had a pungent odor. The right kidney weighed 600 gm., and the left 120 gm. From the anterior portion of the lower pole of the right kidney a large cyst was seen. This cyst was yellowish amber in color, shiny, and 10 cm. in diameter. The upper pole showed another large cyst, about 5 cm. in diameter, and similar in appearance. The capsule of the kidney was thick, and bound down to the underlying kidney substances by numerous adhesions. The left kidney was free of any large cyst, but showed two small cystic bodies, measuring 3 mm. in diameter. The kidney was rather small, and purplish in color. The microscopic examination of the liver showed evidence of portal cirrhosis. The cyst of the liver was lined by cuboidal epithelium. The microscopic examination of the kidneys showed marked thickening of all the arteries. Many of them were fibrosed. The kidney tissue between the cyst and the capsule was very compressed, and in various areas replaced by fibrous tissue. Only an occasional glomerulus was seen in this area. The tubules stained well, and the nuclei were prominent, showing no abnormal features.

This type of case has been frequently observed. It is not uncommon to find cysts in the liver, together with renal cyst. Their relationship is not definitely known. There were also two solitary cysts in this kidney. The question arises whether this case should be classified with true solitary serous cysts.

Case x. S. L., Jewish, white, female, married, aged sixty, entered the hospital with a right lobar pneumonia. The patient had nothing in her past or present history suggestive of renal or abdominal pathology. The physical examination showed signs of a right lobar pneumonia. The patient expired after being in the hospital for forty-eight hours. The autopsy examination showed a right lobar pneumonia, and atelectasis of the left lung. The right kidney weighed 120 gm. The left, including a large cyst in the upper pole, weighed 380 gm. The cyst of the left kidney bulged out from the upper pole, was about 15 cm. in diameter, and was fluctuant. The capsule of the kidney was thin, stripping easily, there being no adhesions between it and the underlying surface. This was the only cyst seen in the kidney. This case illustrated very well the reason for the differences between the incidence of solitary cyst, according to the urologist, and according to the pathologist. This patient has a cyst of her left kidney, 15 cm. in diameter, which gave her no symptoms, and which was not felt or diagnosed by four physicians, who examined her prior to her death.

CONCLUSIONS

1. Ten solitary cysts have been encountered during the past four years on the urological service of a hospital having a capacity of 185 beds.

2. The etiology of solitary cysts remains undetermined. Within the last year, Hepler presented very careful experiments which advanced the theory of infarcts and tubular obstruction as factors producing these cysts. However, the experiments of Latteri, in which he produced solitary cysts by implanting fragments of the mucosa of the ureter or renal pelvis into the kidney parenchyma, added additional strength to the theory of congenital pathogenesis.

3. The clinical diagnosis of solitary cyst is possible. With better *x*-ray facilities, the diagnosis can be more frequently made. Yet in the absence of adequate urological studies, the diagnosis is very often unsuspected.

4. Intravenous urography intensifies the roentgenographic outline of cysts, and will often demonstrate changes in the size and shape of the kidney which are not observed in retrograde pyelography.

5. In about 40 per cent of the kidneys which contain solitary serous cysts addi-

tional pathological lesions are present. Two cases of tumor of the kidney, 2 cases of renal calculi, and one case of cyst of the liver co-existed with a solitary cyst of the kidney in 5 of the 10 cases reported in this paper. It is important that these co-existing lesions be recognized preoperatively and a plan of treatment instituted in accordance with the accepted methods for the type of lesion present.

We wish to express our thanks to Dr. E. Granville Crabtree for permission to report his cases; to Dr. Carl Bearse for permission to report his case; and to Dr. Monroe J. Schlesinger for the pathological reports, and for his advice in the preparation of this paper.

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NEW PYELOGRAPHIC TECHNIQUE

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THE extensive use of intravenous pyelography by the general practitioner has not, as prophesied by many, resulted in cystoscopy becoming an unnecessary procedure; but, by supplementing ureteral catheterization, it has in many instances replaced retrograde pyelography and thereby diminished the frequency of renal colic and other annoying postoperative symptoms.

Retrograde pyelography was discovered in 1906 in Germany and introduced into the United States three or four years later. Because of the occasional untoward results, the urologists next concentrated on discovering a non-toxic, inexpensive opaque medium that would be non-irritating to the kidney pelvis, and in 1918 13½ per cent sodium iodide came into general use.

A satisfactory drug having been found, the scientists then directed their attention to technique, and for many years there were acrimonious debates as to the relative merits of fillings by syringe pressure or gravity. There have also been two distinct schools of thought with regard to the method of making urograms: one standing strongly for only one urogram at a sitting on grounds of "safety for the patient"; the other maintaining that bilateral visualization at a single sitting was safe and preferable. I have always been a strong advocate of the latter opinion, for there is adequate and constantly increasing proof that bilateral injection is just as safe as ureteral catheterization.

It is very discouraging to the operator to make a pyelogram and discover too late that it is unsatisfactory. Syringe pressure always produces a filling, but when a pressure gauge is introduced it is truly surprising how little force it takes to register 200 to 250 mm. on the gauge, and since 250 mm. of pressure is sufficient to split the pelvis of a rabbit's kidney and tear deep into the kidney substance, the frequent over-injections with resultant prolonged kidney colic are explained. Gravity injections with the burettes not elevated over 18 inches have continued their deserved popularity for obvious reasons.

Because of improperly attributing to bilateral pyelography anuria, surgical shock and even death that followed urethral and ureteral traumatization, as well as over-injections, for years many outstanding urologists did only unilateral pyelograms, although they paradoxically continued routinely to perform bilateral ureteral catheterization. With the recent introduction of intravenous pyelography there was an immediate realization of the value of the simultaneous pictorial delineation of both kidneys, and no longer are their patients subjected to the expense and discomfort of two operations.

Intravenous urography was a distinct advance in that it is generally not necessary for the patient to have a cystoscopy in order for us to visualize his kidneys. Unfortunately, although the intravenous dye usually outlines the body of the kidney well, it does not always show clearly the defects in the pelvis. The retrograde method is purely anatomical, while the intravenous is primarily physiological; and, of course, the urologist is searching for anatomical defects when he makes pyelograms.

Those whose surgery was guided by data obtained wholly from intravenous urograms quickly found themselves in trouble. Frequently there was a surgical kidney outlined on one side and nothing on the other. Since the pictures depended wholly upon secretion, the blank side might be due to a congenital absence of

kidney, a "dead kidney," an "acute" stone in the ureter with resultant temporary anuria, a ruptured or traumatized kidney,

Fig. 1. Retrograde pyelograms, 13½ per cent sodium iodide with 16 inches' gravity pressure, of a fifty-eight year old obese woman, with chronic cholecystitis, bilateral colon pyelitis, and slow coagulation time, who had had a right nephropexy done in 1894, at which time a surgical needle used in one of the suspension sutures was broken and lost. Right kidney pelvis is in spasm. Because of severe kidney colic, morphine gr. ¼ (hypodermically) was given, and this precipitated an adynamic ileus complicated by anuria of five days' duration.

Fig. 2. Intravenous pyelogram, same as Figure 1. Because of a septic temperature, patient was recystoscoped six days later to rule out kidneys as source of infection. Intravenous injection of neo-iopax with No. 7 ureteral catheters plugged. Kidney pelves are well filled and excess is flowing down around catheters into bladder. Right kidney pelvis is fairly normal except for old abscess cavity above. There was no reaction of any kind from this examination. (Four weeks later her urine was sterile.)

or even a pelvic stone that blocked the ureteropelvic orifice. Since all of the data obtained at cystoscopy are prerequisite for an exact diagnosis before any renal surgery is done, the next logical step was a combination of intravenous and retrograde pyelograms.

My routine for a kidney investigation is to have the patient enter the hospital the night before, since a nervous, dehydrated person will have a misleading phthalein secretion and a poor secretory pyelogram. Water is forced during his waking hours and he must have at least one liter before going to sleep and another in the morning before going to cystoscopy.

Three grains of a barbitol product (preferably sodium amytal), as an analygesic and as an insurance against any untoward effect from the local anesthetic, are given upon retiring and again at 7:00 A.M. At 7:30 he is catheterized and a sterile specimen sent to the laboratory for culture, and through the catheter an ounce of a local anesthetic (4 per cent novocaine, 1:1000 nupercain or 2 per cent metycaine) is injected. At 8:00 the patient in the cystoscopy room is given ¼ grain morphine, hypodermically. Cystoscopy is then done with little disturbance to the dozing

patient. There is always a free flow of urine from the kidneys. Specimens are collected for microscopic examination and cultures and then phenolsulphonphthalein is injected intravenously, the appearance time noted and collections made over two fifteen-minute periods. An ampule of neo-iopax is injected intravenously and a flat plate 14 × 17 inches immediately made. The table is then placed in the Trendelenburg position and the catheters plugged with sterile toothpicks or victrola needles, and five minutes later a second picture (stereoscopic) is made and the plate developed. If there is a satisfactory filling the other stereoscopic picture is taken. In very rare cases, when the pelvic outline is not sharp, 13½ per cent sodium iodide is injected through the catheters by means of two 25 c.c. burettes attached to a ring stand so there cannot be more than 18 inches of pressure. The fourth picture is a vertical, with the catheters removed at the instant the picture is taken (this is primarily to show the outline of the ureters and ptosis of the kidneys). The patient is then sent to his room, placed in a hot bath for fifteen or twenty minutes to relieve or prevent kidney colic, and he usually goes home in the afternoon.

In both the intravenous injection with the catheters plugged and the combination of intravenous and retrograde pyelograms, we have well-marked kidney outlines and pelvic filling on each side. The patients who do not have a retrograde filling have less discomfort than the others and there is no spasm of the pelvis to distort the outline.

SUMMARY

After a routine kidney investigation, while the catheters are in position and plugged, intravenous pyelograms should be made. The patient will not be subjected to kidney colic due to pelvic irritation, and clear-cut urograms in addition to a good outline of the kidney substance will be obtained.

CHANGES IN TECHNIQUE OF

CERVICOTHORACIC GANGLIONECTOMY AND TRUNK RESECTION

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THE continuous traction of the skin over the spinous processes of the seventh cervical and first and second thoracic vertebrae of patients with scleroderma has resulted occasionally in separation and delayed healing of the wound. This was partially corrected by resecting the tips of the spinous processes before closing the wound. I have later learned that a much better closure of the dorsal fascia and aponeurosis can be made if the incision is placed over the tips of the spinous processes rather than parallel on each side. This allows the common

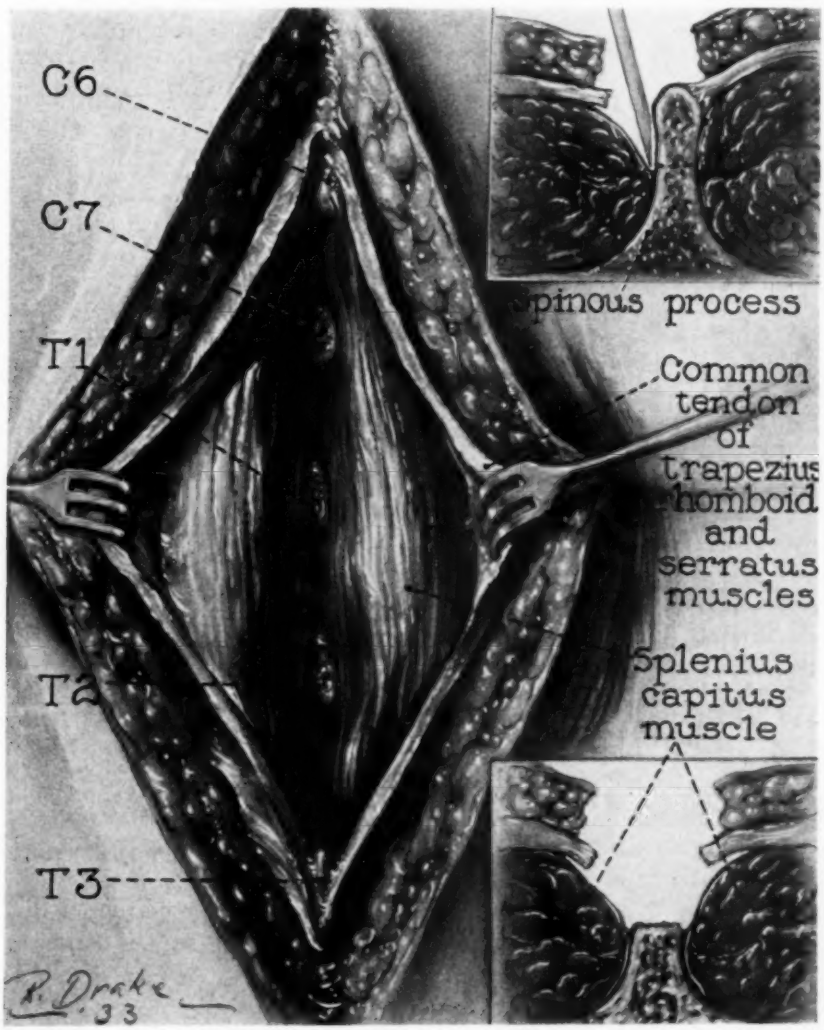

FIG. 1. Dorsal median line incision, with reflection of common tendinous aponeurosis of trapezius, rhomboid and serratus muscles, and procedure in resecting spinous processes.

aponeurosis of the trapezius, rhomboid and serratus posterior superior muscles to be reflected, which affords a stronger support

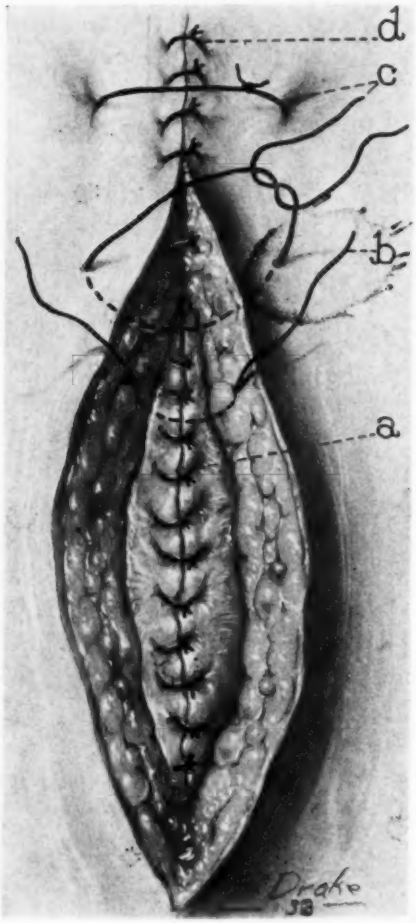

FIG. 2. Closure of wound: *a*, interrupted sutures of number 1 chromic catgut in aponeurosis of common tendon; *b*, interrupted sutures of silk; *c*, sutures of silkworm gut and *d*, interrupted sutures in skin.

for closure. The tips of these spinous processes are removed as formerly described.

I have tried the hockey-stick and transverse incisions, but both failed to give the degree of exposure given by the dorsothoracic median line incision.

I am still of the opinion that the intrathoracic approach through the first rib is superior to the approach through the second rib, and that the same vasodilating effects should be obtained in the peripheral arteries of the hands following cervicothoracic ganglionectomy and trunk resection as that obtained in the feet following lumbar ganglionectomy and trunk resection when all of the vasomotor fibers to the arteries of the arms, hands and fingers are divided.

The occasional occurrence of continued pain, discoloration, and cyanosis of a digit after sympathectomy for Raynaud's disease have always been seen to occur in a digit that was ulcerated before operation. There has been considerable speculation relative to the etiology of this phenomenon. However, since the introduction of arteriography the explanation is comparatively simple; Allen has shown that thrombosis has occurred in the terminal phalangeal arteries in cases of Raynaud's disease.

The alterations in the technique are well illustrated by Figures 1 and 2. The common aponeurotic attachment of the trapezius, rhomboid and serratus posterior superior muscles is lifted off the spinous processes and freed from the splenius capitis muscle in order to expose the transverse process with its articulation with the first rib on each side of the spinal column. The technique is then the same as previously described, except for the closure, which now is much like that used for a laminectomy wound. Interrupted sutures of chromic catgut number 1, placed in the common aponeurosis, include the intraspinous ligament to prevent formation of any enclosed, vacant spaces. As the aponeurosis is composed of fibrous tissue, one can sew firmly to prevent subsequent separation in slowly healing wounds, as in scleroderma. Silk-worm sutures are not necessary if interrupted subdermal sutures of silk are used.

COMMENT

The changes in incision and closure are important since they permit ample exposure, make closure of the wound easier, and prevent separation of the wound following removal of dermal sutures.

TIME-SHOCK FACTORS IN GENERAL ANESTHESIA

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ANESTHETISTS of experience know that there is often a marked difference in the ability of different individuals to withstand anesthesia and operation. It is the purpose of this paper to tabulate and briefly discuss the fundamental intrinsic and extrinsic conditions that modify and control a person's ability to undergo with safety surgical interference under general anesthesia, with special reference to Time as a factor in the production of surgical shock. These "time in shock" factors will be referred to as "time-shock" factors and will be discussed in relation to anesthesia and surgery under the following headings: (A) Time-shock Factors Related to the General Condition of the Patient; (B) Time-shock Factors Related to the Operation; (C) Time-shock Factors Related to the Anesthesia.

A. TIME-SHOCK FACTORS RELATED TO THE GENERAL CONDITION OF THE PATIENT

These factors may be subdivided into two categories: (1) *obvious* time-shock factors in general condition, and (2) *indeterminate* time-shock factors in general condition.

(1) *Obvious Time-shock Factors in General Condition.* Under this head one would include the usual data pertaining to the patient's anatomical structure and physiological function that are reviewed in making an estimate of his ability to undergo operation and in determining the choice of anesthetic agent. They include consideration of (a) pathology and function of the heart, kidneys, lungs etc.; (b) the presence of dehydration, anemia, etc.; (c) the presence of such wellknown endocrine disturbances as diabetes, hyperthyroidism, or rarely Addison's disease.

(2) *Indeterminate Time-shock Factors in General Condition.* Under this head it is suggested that different patients show a varying degree of resistance to anesthetic and operative time-shock factors. This variation in operative stamina in patients occurs in all degrees from the man who successfully withstands five or even six hours of anesthesia for a difficult brain operation to the man who succumbs to the first few "whiffs" of anesthesia (see Case 1).

This varying degree in resistance to anesthetic and operative shock seems to be analogous to the variation in individual resistance to infection often seen in general practice. In three well-known endocrine dysfunctional conditions: hypothyroidism, diabetes and Addison's disease, there is a marked lowering of the individual's resistance to infection. Accordingly one might well surmise that the lack of resistance to infection and anesthesia shown by certain apparently normal individuals may be due to an unsuspected hypofunction of important endocrine glands such as the adrenal cortex and the thyroid gland.

That there is an endocrine basis in one's ability to withstand anesthetic and operative shock is strongly suggested by the recorded observations of many workers in the realm of animal experimentation. Marine[1] reports that the majority of dogs in Cleveland, Ohio, have goiter and are poor anesthetic risks. F. Hartman[2] reported that a cat after total adrenalectomy and while kept in apparent normal condition by daily injections of "cortin" (a potent extract of the adrenal cortex first isolated by Prof. Hartman) proved to be a poor operative risk, dying under skilled ether anesthesia of a few minutes' duration. F. Hartman[3] and others[4,5] have noted that animals with a complete or partial corticoadrenal insufficiency are prone to develop

respiratory and pyogenic infections. The afore-mentioned observations indicate that in animals, lack of resistance to infection and anesthesia may be due to similar endocrine hypofunction.

Recent work in cortico-adrenal insufficiency by Firor and Gollman[6] shows that rats, like other animals, can not survive a *complete* bilateral adrenalectomy. (It has been repeatedly shown that death of adrenalectomized animals is due to loss of the cortex and not to the loss of the adrenin-secreting medulla of the adrenal gland.) Firor and Gollman reported that the length of survival of rats of equal age is directly controlled by (a) their preoperative care, (b) the skill of the operator, (c) the duration (time factor) of the ether anesthesia, (d) the postoperative care. They report also that dogs adrenalectomized under spinal anesthesia had a survival time four times as long as a control group adrenalectomized under ether anesthesia.

It should be noted at this point that F. Hartman and his co-workers and others have shown that even completely adrenalectomized animals will survive indefinitely in apparent good health as long as they are daily supplied with injections of a potent cortical extract. *Such animals, however, are below par in their ability to withstand fatigue, cold, infection, and anesthesia.*

It is highly probable that there is a direct and important relationship between the adrenal cortex, the thyroid gland, and lymphoid tissue in general, including the thymus gland. The clinical evidence for this statement is as follows:

(a) Young adults suffering from Addison's disease (now definitely known to be due to aplasia or disease of the *adrenal cortex*) often show, on autopsy, enlargement of the mesenteric lymphatic glands and the thymus.[7, 8, 9]

(b) Young adults suffering from Graves' disease commonly show on autopsy, enlargement of the lymphoid tissues including the thymus gland.[10, 11]

(c) The lymphoblastic hyperplasia of both Graves' disease and Addison's disease is reflected in the blood as a relative lymphocytosis as high as 60 per cent of leucocytes.

(d) Recent clinical investigations by Crile and his co-workers would indicate that there exists a functional relationship between the thyroid gland and the adrenal cortex.

The experimental evidence for this postulated cortico-adrenal-thyroid-thymus-lymphoblastic tissue relationship is very strong. It may be briefly summarized as follows:

(a) Bilateral two-stage adrenalectomy in dogs results in the death of the animals with typical signs of cortico-adrenal insufficiency; in every case, post-mortem examination reveals *marked enlargement of the mesenteric lymphatic glands and the thymus gland.* Necrosis of the liver is also a constant finding.[12]

(b) Partial cortico-adrenal insufficiency operatively established in dogs is compatible with apparent health (with a lowered resistence to infection); the post-mortem examination of such experimental dogs shows pathological findings strikingly similar to those of status lymphaticus or Graves' disease or Addison's disease, viz., enlargement of the mesenteric lymphatic glands and the thymus gland. These dogs often develop tonsils, these being unusual findings in a dog.[13]

(c) Jaffe[14] has shown that the thymus of rats regenerates after adrenalectomy. Marine[15] and his co-workers have shown that, in the rat, (1) thyroidectomy hastens the involution of the thymus gland, and (2) adrenalectomy causes regeneration of the thymus gland and the lymphoid tissues.

(d) Marine[16] has shown that, in the rabbit and cat with intact thyroid gland, a transient symptom-complex which closely resembles Graves' disease can be produced by sufficient but sub-lethal injury to the adrenal glands. The outstanding symptoms are increased metabolism, myasthenia, increased appetite, increased irritability and increased susceptibility to drugs. These symptoms are accompanied by

regeneration of the thymus gland and hypertrophy of the lymph glands.

The foregoing clinical and experimental evidence indicates that there exists a definite endocrine relationship between the adrenal cortex and the thyroid gland and between both these glands and the lymphoblastic tissues including the thymus gland. Dysfunction of either the vital adrenal cortex or the important thyroid gland in young adults most commonly results in enlargement of the thymus gland and the mesenteric lymphatic glands. *Conversely, the post-mortem finding of enlargement of the thymus gland and the mesenteric lymphatic glands indicates, ipso facto, the pre-existence of dysfunction of either or both the adrenal cortex and thyroid gland.* It is common knowledge that, without careful preoperative preparation, patients with the form of thyroid dysfunction commonly known as hyperthyroidism are decidedly poor operative risks. Likewise, the victims of Addison's disease are poor anesthetic risks. *It follows, therefore, that the post-mortem finding of enlargement of the thymus gland or the unaccountable hyperplasia of the mesenteric lymphatic glands indicates that the individual in question was handicapped by a partial dysfunction of the adrenal cortex or the thyroid gland or both and with such a handicap was not able to withstand the time-shock factors of anesthesia and operation.*

This conception was reached independently of, but is in close harmony with, the late Prof. Warthin's theory concerning the existence of the so-called "Graves' constitution (Warthin)."[17] According to this opinion of Prof. Warthin and his pupils, certain individuals are congenitally predisposed to develop Graves' disease or, in other words, are possessed of a "Graves' constitution." The main anatomical stigmata of this "Graves' constitution (Warthin)" are (a) a "persistent" hyperplastic thymus; (b) a generalized hyperplasia of the lymphoid tissue throughout the body especially in the thyroid gland; (c) hypoplasia of the adrenal glands; (d) underdevelopment of the vascular system particularly the heart and aorta. The lymphoid hyperplasia seen in the microscopical examination of the excised thyroid gland is the anatomical feature of diagnostic significance. "While the individual with this constitutional abnormality is always potentially a subject for so-called thyroid disease, the condition may be dormant throughout his lifetime." (C. H. Fortune.)

From a consideration of the clinical and experimental evidence advanced in the preceding paragraphs, it is the writer's opinion that "Graves' constitution (Warthin)" is a real clinical entity and *is essentially due to hypofunction of the adrenal cortex.* Individuals stigmatized with this postulated hypofunction of the adrenal cortex will show on post-mortem examination some of the pathological findings mentioned in the preceding paragraph and they are fair or poor anesthetic and operative risks according to the degree of adreno-thyroid hypofunction that they possess.

The following briefly presented case histories are illustrative of this viewpoint:

Case I. Mr. E. G., an apparently normal, well-developed, white male of thirty-five years.

In preparation for tonsillectomy, anesthesia was induced with ethyl chloride and ether without any struggling or spasm. Early in the second stage of anesthesia his respirations suddenly ceased and he was pulseless. Resuscitative efforts were without effect. Autopsy revealed no anatomical abnormalities except a thymus gland of 26.3 gm., a thyroid that appeared to be larger than normal and weighed 35 gm.; an enlarged spleen and definite enlargement of the mesenteric lymphatic glands.

Case II. Miss P., a "half-breed" Indian girl of thirteen years, well-developed and an apparently good operative risk.

Anesthesia was induced without any abnormal occurrence. During the dissection of the first tonsil, her blood color became cyanotic and respirations and heartbeat suddenly ceased as the tonsil was removed. Resuscitative measures of every known type were used without effect. Autopsy revealed little evidence of

abnormality except a thymus gland of 38 gm. and some slight hypertrophy of Peyer's patches and the mesenteric lymphatic glands. On gross examination the adrenals "appeared normal."

Case III. Child D. D., an apparently normal white girl of six years.

In preparation for tonsillectomy and adenoidectomy, surgical anesthesia was normally induced with ethyl chloride and ether. At the end of thirty minutes' anesthesia, during which time the tonsils were carefully dissected out and bleeding points ligated, the child's color suddenly became dusky and the respirations became gasping in type. The pulse was present but was weak. Pulse and respirations soon ceased entirely and after forty-five minutes' active resuscitative efforts the child was pronounced dead. Autopsy revealed nothing of note except a thymus gland of 25 gm. and definitely enlarged mesenteric lymphatic glands.

Case IV. Child L. B., an apparently normal white boy of six years.

In preparation for tonsillectomy, ether anesthesia was normally induced and easily maintained by intrapharyngeal oxygen-ether vapor. The surgeon, a very thorough but slow operator, had just completed satisfactory hemostasis in the fossae after one hour's anesthesia, when the child collapsed and could not be revived. Autopsy revealed a thymus gland of 53 gm. The mesenteric lymphatic glands were not examined.

Case V. Miss K. O.'G., an apparently normal white girl of sixteen years.

The case was diagnosed as acute appendicitis. Under intratracheal ether anesthesia a difficult retrocecal and acutely inflamed appendix was removed. The patient had a brief attack of so-called "deep ether convulsions" during the course of the operation but these were readily checked by the carbon-dioxide rebreathing technique which has been previously reported.[18,19] One hour after induction of anesthesia the patient suffered a sudden cardiac and respiratory collapse. She was practically dead for fifteen minutes (the surgeon could feel no heart beat on subdiaphragmatic palpation) and was subsequently revived by adrenalin injection in intravenous saline infusion. Although circulatory and respiratory functions were temporarily restored, the patient died ten hours later. On autopsy "no anatomical cause of death was found." The thymus gland weighed 25 gm. and the mesenteric lymphatic glands were not enlarged.

Discussion of Case Histories. In consideration of these case histories, the argument in favor of the existence of "Graves' constitution (Warthin)" in each of the patients centers around the size of the thymus gland. This gland is admittedly a much disputed criterion upon which to hang any argument. Upon one point there is general agreement, namely, that the thymus reaches its maximum size at puberty, and in normal individuals, it then regresses, until, in adult life, it can scarcely be seen. The disputed point in regard to the thymus concerns the so-called "normal" weight of this gland in children under the age of puberty. It would seem that the figures compiled by Anderson and Cameron[20] of Glasgow in 1927 are near *the real normal* inasmuch as they were obtained from autopsies on children dying purely accidental traumatic deaths. The last point is important because, as Marine points out, the thymus gland undergoes remarkable and rapid involution in children subjected to acute infection or inanition. In this series of one hundred autopsies in which children showing recognizable signs of status lymphaticus were excluded, the maximum weight of the thymus was 15 gm. It can not be over-emphasized that the thymic weight, from a diagnostic viewpoint, must be considered in relation to the nutrition and the presence or absence of acute infection. With these points in mind, it appears that the thymus glands in the foregoing cases were all abnormally large.

Actual knowledge of the real condition of the adrenal cortex and other important endocrine glands in cases of sudden unexpected death on the operating table and elsewhere must wait until such time as pathologists recognize the great importance of an immediate autopsy and a thorough microscopic examination of the vital glands.

(B) TIME-SHOCK FACTORS RELATED TO THE OPERATION

The time-shock factors related to the operation and under the direct control of the surgeon will be considered under the following headings: (1) the lack of preoperative preparation; (2) the shock-producing nature of the operation; (3) a shock-producing method of operating; (4) the dehydration incidental to operation.

(1) *Lack of Preoperative Preparation.* The proper preparation of the patient for operation is the most important and the least attended phase of elective surgery. A patient who is risking death in undergoing major surgical procedures should at least be as thoroughly "trained" as the athlete who risks the loss of a piece of ribbon or a medal in a foot race. Only in the cases of thyroidectomy are reasonable preoperative "training" measures commonly taken.

(2) *Shock-producing Nature of the Operation.* The nature of the proposed operation is undoubtedly of great importance as a time-shock factor. For example, operations on long bones such as the femur are notorious for their tendency to produce shock, due, presumably, to the liberal supply of depressor nerves in the medullary portion of all long bones.

(3) *Shock-producing Method of Operating.* Many otherwise excellent surgeons are unduly rough in handling the viscera. Visceral traction is a potent producer of shock. Tight upper abdominal packs and the high Trendelenburg posture in obese patients are, in time, shock-producing factors.

(4) *Dehydration Incidental to Operation.* In the last analysis, surgical shock manifests itself as anhydremia or blood dehydration. It therefore follows that any process that creates a loss of body fluids such as hemorrhage or perspiration is a time-shock factor.

(C) TIME-SHOCK FACTORS RELATED TO THE ANESTHESIA

The important factors related to the anesthesia which in time produce shock are: (1) fear; (2) a rapid or stormy induction; (3) the use of an unsuitable anesthetic agent; (4) the maintenance of an unsuitable plane of anesthesia; (5) failure to offset dehydration; (6) failure to maintain an open airway and adequate blood oxygenation; (7) irrational or handicapping posture on operating table; (8) undue cooling of the patient.

(1) *Fear* of anesthesia and operation is a powerful time-shock factor. The general use of pre-medication and sleep-inducing therapy the night before operation have done a great deal to prevent the devastating effect of fear upon the nervous system of the preoperative and frightened patient.

(2) *A too rapid induction* into surgical anesthesia does not allow the patient to become adjusted gradually to the new conditions and is therefore an important time-shock factor. *A stormy induction* is often the result of repressed fear and as such is due to faulty preoperative preparation, both medicinal and psychic.

(3) *The use of an unsuitable anesthetic agent* may, in time, cause shock either because it is unsuitable to the patient's condition, to the type of operation, or to the demands of the operator.

(4) *The maintenance of an unsuitable plane of anesthesia* is comparable to the use of an unsuitable anesthetic agent as a time-shock factor. To maintain light or second-stage anesthesia when the needs of the operator demand the utmost in muscular relaxation is a time-shock procedure that is comparable to the maintenance of deep or third-stage anesthesia when the operation permits the use of second-stage anesthesia.

(5) *Failure to offset dehydration* is obviously a negative time-shock factor. It is decidedly the duty of the anesthetist to adequately offset the dehydrating factors incidental to operation by the use of subcutaneous or intravenous fluids.

(6) *Failure to maintain an open airway* and adequate blood oxygenation is in time conducive to shock. This failure to prevent anoxemia is a potent and subtle time-shock

factor. Its ill effects may not be manifest until the postoperative period.

(7) *An irrational or handicapping posture on the operating table* is obvious to all if it is sufficiently extreme. With few exceptions,[21] we are all guilty of using, in the operating room, a posture that would be the last one to suggest itself if we contemplated making a pelvic examination in the office, viz., the Trendelenburg position in which the abdominal muscles are put on the stretch.

(8) *Undue cooling of the patient* is brought about by low temperature environment and insufficient coverings. Of these, the room temperature is obviously the most important time-shock factor. The old method of administering ether by the drop method on a mask is conducive to undue cooling of the inhaled air and indirectly lowers the patient's temperature or forces the expenditure of valuable energy to maintain a normal body temperature.

SUMMARY

The factors which, in time, produce surgical shock (time-shock factors) are tabulated with a brief discussion of the indeterminate or endocrine factors in the production of sudden and often fatal shock. It is suggested that individuals who die suddenly on the operating table (or elsewhere) in whom autopsy shows a thymus gland that is larger than normal with (often) hyperplasia of the mesenteric lymphatic glands or Peyer's patches, are handicapped in their ability to withstand anesthesia and operation. Clinical and experimental evidence suggests that the basic endocrine hypofunction is that of the adrenal cortex primarily, and secondarily, dysfunction of the thyroid gland.

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CONVULSIONS UNDER DEEP ANESTHESIA

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SEARS[1] reported 2 cases of convulsions under deep ether anesthesia. He reviewed the literature on the subject and gave a résume of the opinions of various commentators on the cause of this condition. The very fact that there are so many different causes ascribed for the condition, causes one to believe that there may be different types coming under the observation of these different reporters, and the phenomenon observed by one may be entirely different from that observed by another.

My own opinion is that there are at least three types of convulsions occurring under anesthesia. Every surgeon has observed the convulsions of beginning ether or nitrous-oxide narcosis. These convulsions are of a coarse clonic type, in the case of nitrous oxide often becoming tonic with great danger of asphyxia. These convulsions are probably respiratory in origin and due to too rapid administration of the anesthetic, with backing up in the blood of excess carbon dioxide. Usually withdrawal of the anesthetic will suffice to stop the convulsion.

Then during the War there were reported a number of toxic deaths from ether. This, I believe, was found to be due to toxic impurities in the ether, and the source of contamination being found and eradicated, no further difficulty was experienced with ether. Convulsions, as I remember, were a prominent symptom in those deaths. I have never seen this type, but literature contained innumerable references to it at that time.

However, there is a type of convulsion which occurs in deep ether anesthesia that I believe bears very little relation to the foregoing. It usually occurs in extremely toxic patients and usually in young children. The course is something like this: The anesthesia is progressing very nicely; there is no cyanosis or pallor, the respirations are full and normal, the pupils are contracted down in the third stage of narcosis. The anesthetist first feels a tightness in the muscles of the throat as he holds the mask, and thinking that the patient is probably coming out, he usually looks at the pupils and finds them dilated. Then he is sure that the patient is coming out and gives more ether with the result that the tightness increases. Usually he then notices a twitching of the eyelids and possibly of the eyeball, and facial muscles. Following that the convulsions, in true epileptic fashion, spread to the muscles of the arms, then the legs and finally the abdomen. If ether is given they are increased. Oxygen has no effect upon them whatever. Chloroform stops them immediately. This type is probably due to an intense toxemia which acts as a sensitizing agent, and the ether, which normally would be without effect, becomes enough of a cerebral irritant to initiate the convulsion.

The following case illustrates this type:

The patient was a child two years of age. The birth had been difficult, with instrumentation and the baby had been bottle fed. However there was no history of birth injury or convulsions at any time. The baby had done well under a formula and was somewhat over normal weight with a rather pasty or waxy color to the skin. The blood count was: red blood cells 5,115,000; leucocytes 22,000; polymorphonuclears 92 per cent; temperature 106°F.; respiration 50; pulse 140. The urine showed no kidney involvement and was normal in amount. The pediatrician found no evidences of thymus or other endocrine derangement. Four days previous to admission she became sick with nausea and vomiting and other signs

[1] *J. A. M. A.*, 100: 1150, 1933.

of an intestinal upset. There was no localized tenderness or rigidity until the morning of admission. On admission there was no question of an acute condition in the abdomen, probably a ruptured appendix. On operation, done at once, generalized peritonitis was found with a little more exudate and reaction around the appendix than elsewhere. The appendix was removed. While tying off the stump, the phenomena just described began. Oxygen was given and removed and repeated. However, no results were apparent. Withdrawing the mask entirely for a few minutes had no effect. Three times we attempted to resume the ether and each time the convulsions became more severe. Finally chloroform was given and the convulsions stopped instantly. The operation was finished under that anesthetic, with no return of the convulsions. There were no convulsions after the operation. The baby was very toxic but perfectly rational until about three o'clock the following morning. She then began to show signs of cardiac failure, with pulmonary edema and finally died about four o'clock.

The convulsions lasted five minutes; total time of anesthesia twenty minutes.

Ether was from a newly opened can of Squibb's ether; only 2 ounces being used. The remaining ether in the can was used in the next operation without unusual results.

The anesthetic was given by an experienced and competent technician in a very careful unhurried manner and by the open drip method.

There was no cyanosis until after the convulsions began.

The organism on culture was found to be Streptococcus viridans.

ACUTE BACK INJURIES

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A SERIES of 200 consecutive cases of acute back conditions occurring within one year are presented, and an attempt is made to compare our findings with those of similar studies, to determine the relative importance of the various signs and symptoms already described. The end-results are based upon the actual costs.

INCIDENCE

Sex: There were 173 males and 27 females in the series. Upon considering this series and a series of 10,000 industrial accidents, it would appear that more women than men complain of back injuries. This seems to be true in private practice, also. We noted that males with unusually large pelves seemed particularly prone to back conditions, and that some of them were our most obstinate cases.

Age: Although the majority of these cases were under forty years of age, Lewy's contention, that back injuries may be divided into "the young man's back" and "the old man's back," was definitely corroborated. The actual cost of a number between the ages of twenty and twenty-five years, and a similar number between fifty and fifty-five years of age, was found to be practically identical.

Our roentgenograms supported the pathological findings of those who claim that all spines of individuals over forty years of age show a beginning hypertrophic osteoarthritis, but in only two instances did it appear that a spur formation had been recently fractured. Thus it appears that aggravation of a pre-existing arthritis, by injury, is of rare occurrence.

Nationality: The greater percentage of our cases occurred in persons of Latin extraction, probably because a large share of our labor is performed by these Southern and Central Europeans. This fact is significant because these people are notoriously temperamental, and the mental element in back injuries is of the utmost importance, and should never be disregarded. The deep and lasting impression made upon the mind by a back injury is probably due to its association with permanent paralysis and sudden death. Our consulting neurologist discovered no evidence of a neurological lesion in the 200 cases, demonstrating that these fears are not warranted.

Constitutional Disorders: Although only three back injuries in our series occurred in the tall, thin and undernourished type of individual, and the chart relative to symptoms shows that back injuries are more prevalent in heavy set or actually obese persons, all of our patients denied any symptoms of a constitutional nature, attributing all of their disability to their accident. In spite of this it seems certain that faulty diet and improper elimination are etiological factors in back conditions.

HISTORY

It is essential that this should be detailed and complete.

Pain: The onset of pain should be determined; whether it was immediate or several days after the accident or supposed strain. Pain in the back is frequently caused by acute myositis following exposure to cold drafts, and by nasal and throat infections, and I do not believe that heavy lifting will predispose to later localization of a systemic infection in the back. Therefore I doubt the causal relationship, unless the appearance of pain is immediate.

Although all of our patients denied having had previous back injuries or attacks of pain, we found upon further investiga-

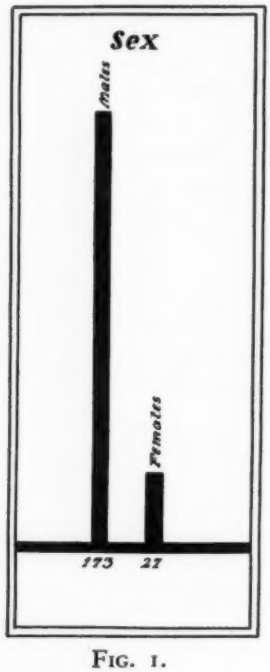

Fig. 1.

tion that eight of them had had previous back pains. In private practice, where there is less reason for concealing facts, it is found that a large number of individuals suffering from back conditions state that they have had repeated attacks of pain over a period of years.

Type of Violence: In order to ascertain the exact nature of the violence, I often have the patient demonstrate the position he was in at the time of injury.

Indirect: One hundred twenty-two patients gave a history of immediate pain following lifting and eight of these claimed they heard something snap in the back at the time of injury.

Direct: Forty-nine patients gave a history of having received a direct blow, although only an occasional one of these showed any objective evidence of a blow.

Undetermined: The type of violence could not be determined in the remaining 29 cases, the patients' being unable to describe the exact manner in which they were injured.

PHYSICAL EXAMINATION

All clothing should be removed in order to properly examine for back injuries.

Posture: With the patient in the erect posture, the direct and lateral postural appearances, the position of the feet, and the posture with heels and toes together should be noted. Although Goldthwait believes that about 90 per cent of patients complaining of back pains have postural defects, we observed only 27.5 per cent in our series, probably because the series was composed largely of young, well-developed persons.

Point of Tenderness: The patient should be told to indicate with one finger the exact spot where the greatest pain is experienced. When there is no definite pathology present, the patient invariably feels about his back with the palm of his hand and is unable to locate the same spot on repeated examinations.

This point of tenderness is the most important diagnostic sign in joint injuries, particularly of the sacroiliac articulation.

Limited Motion: Great care and often repeated examinations are necessary to determine accurately the existence and degree of true limitation of the motions of the back. The patient should be first requested to bend forward and touch his toes with his knees extended. The muscles of the back are then palpated. Contraction of these muscles may be due either to reflex pain or a voluntary attempt to limit bending. I have found that a sharp push forward, as if to assist the patient in bending, is often effective in releasing this voluntary contraction. The greatest distress will be experienced by the patient in reassuming the erect position, when a true lesion is present. All orders for changes in position should be given sharply and directly and the immediate response noted.

The patient should next be told to place his hands behind his head. When there is present a lesion of the back muscles, particularly the latissimus dorsi, there will be a delay in placing the hand correspond-

ing to the side of the lesion. The patient should then be told to bend laterally to the right and left several times, keeping his hands in position. In a true lesion the bending toward the uninjured side is more painful than toward the injured side. Posterior bending should be tested next.

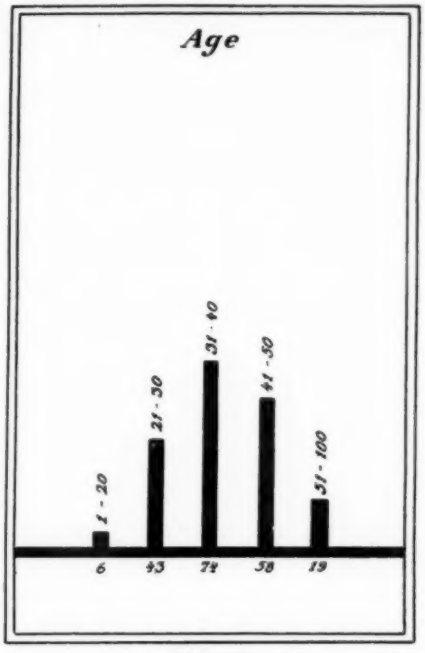

Fig. 2.

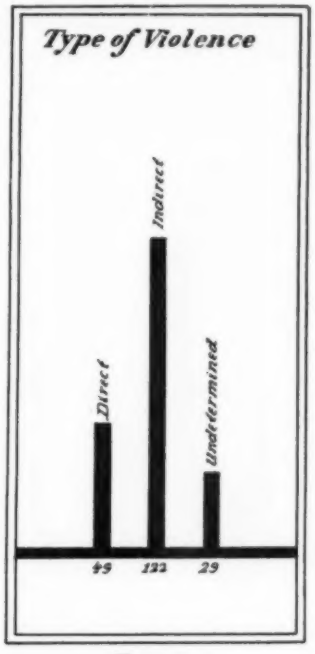

Fig. 3.

The patient should then be seated on a stool and forward, lateral, and posterior bending carried out in this position. Goldthwait observed that a patient suffering from a sacroiliac lesion can bend forward much more freely in a sitting position; whereas, if there is a lesion in the joints of the spine, bending will be attended by the same amount of pain whether executed from the sitting or erect position. We found this test verified by our experience and consider it one of the most accurate methods of determining the presence of a sacroiliac lesion.

Hyperextending the thighs on the pelvis with the patient prone on the examining table will give further evidence of the range of motion. The variation in the extension of each extremity should be noted first, then the range of backward bending when both are elevated together. The points of tenderness present when the patient is in the prone position should be noted and compared with the location of those obtained in the erect position. Patrick's sign is valuable in differentiating arthritis of the hip joint from sciatica or sciatic neuritis and Lasacque's sign indicates disease or injury to the sciatic nerve or the trunks that form it.

Patrick describes the following movements: With the patient in the supine position, either leg is elevated to an angle of 60 to 70 degrees, and the heel of the elevated leg is placed above the patella of the opposite leg, and then abducted and rotated outward, so that the knee can be depressed to a lower level than the knee of the opposite side without provoking pain in the normal individual. If pain is provoked, these movements may indicate arthritis in the hip joint. In sciatica or sciatic neuritis these movements cause no distress to the individual. From these movements of either extremity, no strain is placed on the spinal column, muscles or tendons attached to it, and as far as I know, this test is not in common usage in determining diseases or injuries of the trunk.

Lasacque's sign is elicited in the following manner: With the patient in the supine position, the thigh is flexed on the pelvis to the maximum limits, and then the leg is elevated

to its maximum limits. Ordinarily, an angle of 120 degrees may be formed in this posture of the limb without provoking pain, whereas in diseases of the spinal cord roots, spinal ganglia and nerve trunks, this angle of 120 degrees cannot be made without causing distress to the patient.

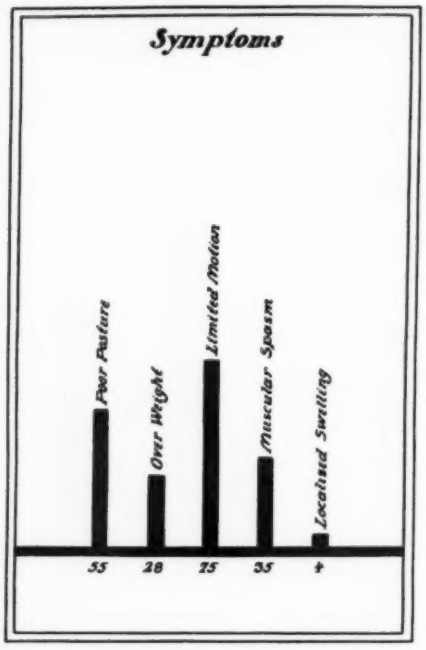

Fig. 4.

Its significance lies in its indication of diseases of the sciatic nerve. In diseases of the back or following trauma to the back Lasacque's sign is sometimes positive since the abnormal posture of the limb has a tendency to flatten out the normal anterior curve. In carrying out Lasacque's test, the flexed extremity will fall loosely downward into the examiner's hand, if the patient is relaxed and properly cooperating in his examination. If the patient is wilfully controlling his efforts, the limb will be held fixed in an elevated position when it is suddenly released by the examiner.

Muscular Spasm: If real lesions of the joints, muscles, fasciae or tendons are present, a contracture of the back muscles will be detected upon palpation when these areas are subjected to motion. A small tender nodule about the size of an English walnut is occasionally felt and indicates a localized muscular contracture. Rapid wave-like contractures running up and down the back are frequently observed. These are generally considered to be superficial twitchings and are not associated with pathology. A leathery rub similar to that felt over a tendinous synovitis of the muscles of the forearm indicates true myofascitis.

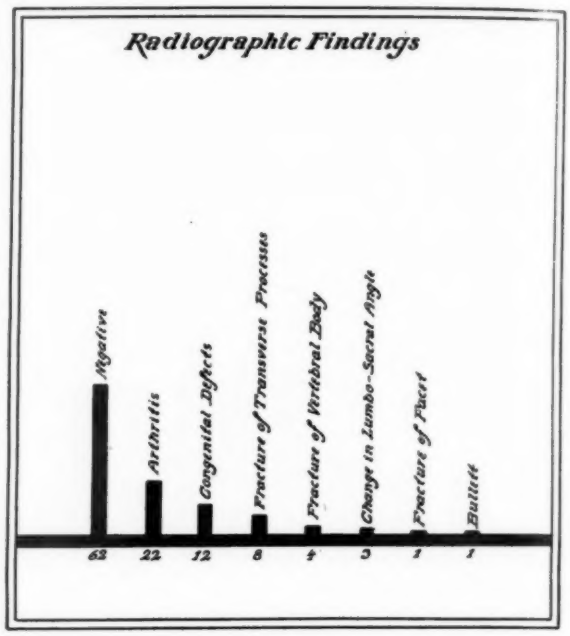

Fig. 5.

Muscular rigidity could be palpated in 35 cases in our series.

Swelling: In rare instances a visible swelling occurs over the lower lumbar region and upper portion of the sacrum, and it is my opinion that this indicates extensive underlying pathology and a prolonged disability period. We observed this condition in only 4 of our cases.

Sounds: In a few cases a sudden sharp report was heard upon examining the back. In a few instances the patient experienced complete relief of his symptoms after the occurrence of this sound. I am not prepared to comment upon the significance of this sound.

ROENTGENOLOGIC EXAMINATION

In our series roentgenologic studies were made of 104 cases. The accompanying chart (Fig. 5) shows our findings.

The recognition of congenital anomalies of the fifth lumbar vertebra is difficult

because no standard normal has been accepted. The most common and the most easily detected of these defects is the

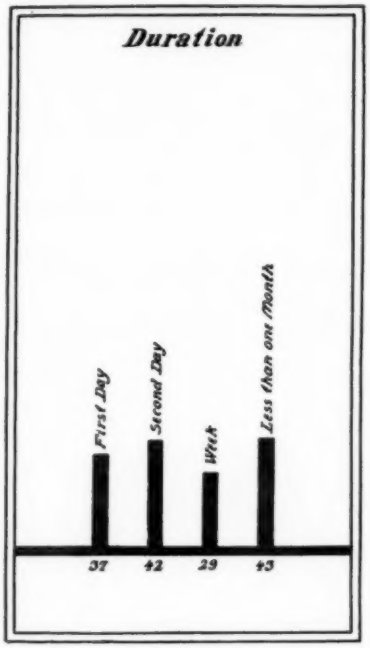

Fig. 6.

improper fusion of the laminae. Another defect often seen is a variation in the relation of the transverse processes of the last lumbar vertebra to the crest of the ilium. Variation in the articulation of the fifth lumbar vertebra and the sacrum also occur, and 3 cases in our series showed a marked derangement of the lumbar sacral angle.

Roentgenologic studies should contain not only anteroposterior and lateral views of the lumbar vertebrae, but also a considerable portion of the dorsal spine, sacrum, coccyx and hip joints.

TREATMENT

Because of the mental element present in these conditions, it is important that the patient's confidence be obtained early and his fears dissipated. This mental therapy should be begun while the history is being taken, and treatment of the back should be begun immediately following the accident. The accompanying chart will show that the majority of our cases were seen within the first three days.

Strapping: An acute sprain should be strapped immediately with adhesive plaster. Two to 3 inch strips should be used and

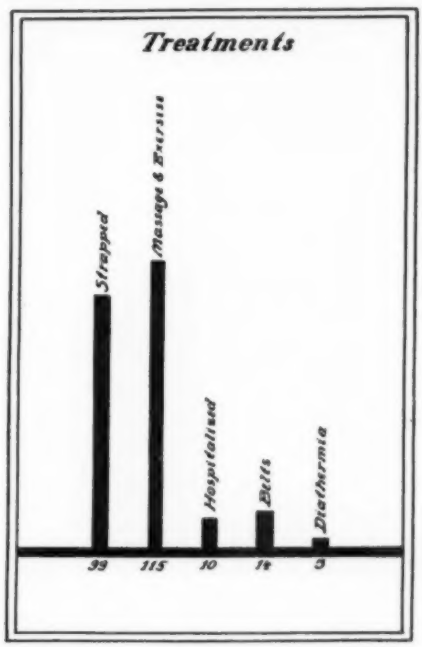

Fig. 7.

applied transversely across the back, extending from the vertical extension of one anterior iliac spine to a similar line on the opposite side, beginning at the level of the middle of the sacrum and continuing to the ninth dorsal vertebra, thus including the lower ribs. The strapping must be applied with force, and the lower strips should be made to firmly grasp the anterior superior spine and crests of the ilia. Should these lower strips slacken following the application of the upper ones, additional strips should be applied over them to firmly fix the sacrum and lower spine. The patient should be in the prone position during this procedure and should be lifted bodily from the table and placed upon his feet at its completion in order not to derange the strapping. Where there has been a true sprain of the muscles of the back, immediate relief is invariably obtained. After five to seven days the strapping is usually no longer required. A few cases have to be restrapped. In 99 cases of our series, this was our primary treatment.

Massage and Exercise: Deep massage should be ordered for the patient following removal of the adhesive strapping, and he should be instructed to carry out voluntary exercises. These should be executed in the presence of a competent physiotherapist.

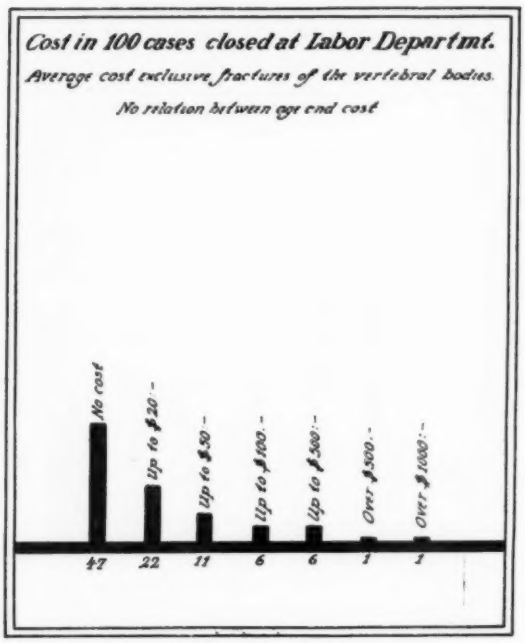

Fig. 8.

In our series 115 patients were treated by this method and the majority were cured within two weeks.

Baking and Diathermia: Although there are some who believe massage can be carried out better after the patient has been exposed to heat, I believe baking forms a very small part of the benefits derived from physiotherapy. Both the infra-red and the usual baking lamp were used in our series and though quite a number of patients stated that they had received decided temporary relief following the application of heat, there was a definite group who complained that the heat aggravated rather than diminished their symptoms.

Diathermia is widely used and favorably advocated by a large number of eminent physiotherapists, but its use in this series of cases did not appear to lessen the disability period as compared with the cases treated solely with deep massage and corrective exercises.

Rest Period and Type of Bed: Where the condition is acute and very disabling, it is advisable to begin treatment with a period of one to three weeks' rest in bed, preferably in a hospital. If the patient must be treated at home, his bed should be fitted with a hard mattress and spring and if this fails to give the proper support, a board should be passed beneath the springs to support them. Only a very small pillow should be permitted.

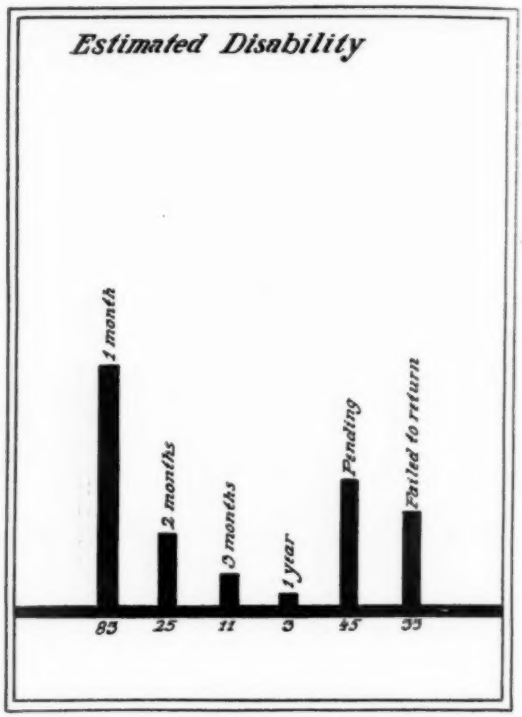

Fig. 9.

Belts: The use of a belt tends to weaken the muscles supported by it, and assuming the majority of back injuries to be a "myofascitis," as described by Albee, a period of immobilization longer than that afforded by strapping would seem to be contraindicated.

We found that the use of a belt reduced the patient's self reliance, prolonged the disability period and tended to make the patient an habitual belt wearer. Therefore, the cost of supplying the patient with a belt can hardly be justified.

Colonic Irrigation: Intestinal stasis unquestionably has a direct bearing on the metabolism of the back muscles, and pain from this cause would probably be relieved by colonic irrigations. However, I do not believe this condition causes extension of symptoms in back injuries. None of the cases in this series was treated with colonic irrigations because in another series in which they were used; most of the patients objected to the irrigations, a number experienced an exacerbation of their symptoms, possibly due to toxins stirred up by the procedure, and there was no hastening of recovery. Unless it is very definitely indicated, this type of treatment tends to unduly alarm the patient.

Manipulation: Manipulation of the spine under a deep general anesthesia, followed by rest for a few days, is advocated by Moorhead and others in chronic conditions in which the types of treatment already mentioned have failed. This procedure, in my opinion, is not applicable to very recent back injuries, as if there be an acute inflammation of any joints, associated with the muscular involvement, forceful manipulation would tend to further irritate the synovial membrane. It seems that the beneficial results which are sometimes obtained should be attributed to the stretching of muscles rather than to the breaking up of adhesions. At a recent meeting of the American College of Surgeons, Willis C. Campbell described a snapping sound heard during a process of manipulation, which he attributed to the breaking up of adhesions. If this sound were truly indicative of the breaking up of adhesions, it seems to me that each successive manipulation, at intervals of from two to three weeks (an interval hardly long enough for re-adhesions to form), should produce a gradually diminishing sound; whereas in my experience there appears to be no difference in the quality of these snapping sounds produced during subsequent manipulation.

Four or five of our cases had been treated by chiropractors. They claimed marked benefit from their treatment, and 3 patients were permitted to continue with these chiropractic manipulations. However, all three subsequently returned to us claiming recurrence of their symptoms.

Alcobolic Injections: Definite nerve lesions associated with back injury rarely occur. This is demonstrated by our series of 200 cases in which no neurological lesion could be discovered. I believe that severe damage to the nerve roots in the lumbosacral area occurs only in association with a fracture. I have never attempted alcoholic injections for the relief of pain arising from a nerve lesion and believe that it should be reserved for a small number of well-selected cases.

Operation: The late Dr. Russell A. Hibbs was the most prominent of the group of surgeons who have advocated fixation of the spine in chronic disabling conditions. His method, an extensive operation, has become a standardized surgical procedure. However, in the few cases operated upon by me for fixation of the lumbar spine, I have used the method of Albee. The end-results in these cases have been excellent, and the range of motion is remarkable.

In the series of cases reported a single bone graft was done for a fracture of one of the lumbar vertebrae. It is my opinion that a surgical procedure should be confined to a very small number of chronic cases.

MALINGERING

A test for malingering has been proposed, utilizing the roentgen ray, but I am not familiar with the method. I use the more simple tests during examination, such as watching the manner in which the patient removes his clothing and picks it up after the examination, and observing the changes of expression and the character of the movements made during this procedure. It is possible to distinguish between the hesitation due to true pain and that due to the desire to make the motions appear painful or difficult. The examining doctors at the State Labor Department consider a

change in the pulse rate to be an important finding in this connection.

HYSTERIA

Back symptoms presumably due to hysteria were seen in 2 cases of our series. In one of these, limitation of motion had persisted for four years and no limitation was demonstrated under anesthesia. In the other case there was a complete recovery following manipulation, and as yet there has been no return of the symptoms.

FRACTURES OF THE TRANSVERSE PROCESSES

The most frequent fractures involving the spine are those of the transverse processes. Although this condition is usually discovered during routine roentgenologic examinations, one can sometimes elicit a definite point of tenderness lateral to the vertebral column and thus make a tentative clinical diagnosis of such a fracture. The condition is usually a result of direct violence and I doubt if it is ever caused by sudden musculur effort.

In our series there were 8 of these fractures, most of them clearly due to direct violence. The symptoms were not as severe as those in most of our back cases in which no fracture could be demonstrated.

Treatment: The same treatment is advocated as that described for treating sprains of the back, namely; strapping, massage and exercises. The exercises should not begin until a period of three or four weeks has elapsed. Recovery is usually rapid and we found that in our 8 cases, the average cost was only $210.00 per case.

One case of fracture of one articular facet occurred in our series. It was treated in the same manner as fractures of the transverse processes, and with equally good results.

FRACTURES OF THE BODIES OF THE VERTEBRAE

Although there were 3 cases of fractures of the bodies of the vertebrae in our series, it is beyond the scope of this article, dealing with acute back injuries, to discuss at length the treatment of this type of fracture. Briefly, they were immobilized for a period of about two weeks on a Bradford frame in hyperextension; following this they were placed in a moulded plaster jacket for a period of about six months, and then in a Taylor back brace for several months longer. In computing our costs, as shown in the accompanying chart, these 3 cases of fracture of the bodies of the vertebrae have not been included as the cases are still pending before the Labor Department.

CONCLUSIONS

1. Acutely painful backs associated with a history of injury are seen most frequently in persons under forty years of age.
2. This acute group is best represented by short, stocky individuals, and rarely by tall thin persons.
3. A definite constant point of tenderness is an important finding, but muscular spasm is the most reliable objective finding.
4. Immediate strapping on the day of the injury lessens the disability period.
5. Corrective, voluntary exercises constitute the most important part of the after-care.
6. A fracture of the transverse processes is not a grave condition, and may be treated in the same manner as a sprain of the back muscles.
7. The disability period in this series of 200 cases was much less than anticipated.
8. The average cost per patient in cases not accompanied by fractures was approximately $70.

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PYOGENIC OSTEOMYELITIS OF THE SACROILIAC JOINT

TREATMENT BY BARDENHEUER-PICQUE RESECTION, MODIFIED BY ORR METHOD*

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PYOGENIC osteomyelitis of the sacroiliac joint is not as uncommon as the paucity of the literature on the subject would lead one to think. About 30 cases have been observed in this clinic. It is my purpose, however, to discuss this lesion clinically in general and to report in detail the last four instances of the condition that have been treated by partial or total resection of the affected sacroiliac joint since January, 1932.

The pathogenesis of osteomyelitis of the sacroiliac joint is similar to that of the long bones. The hematogenous type is a thrombo-embolic phenomenon, and is primary or metastatic secondary to another bony focus. It is obviously a primary joint lesion sometimes because the sacroiliac articulation is a true joint cavity. At least one case has been observed early enough to prove this. Clinically it is usually secondary to bony involvement of the lateral flare of the ilium or sacrum. Its seriousness depends upon the one or the other localization. The sacral seems to be more frequent. Once the joint is involved, extension occurs rapidly and almost inevitably from one bone to the other, making the lesion a total one. It would appear from our cases that sclerotization of the ilium does limit extensive spreading into this bone. Sequestration is not uncommon and is usually situated deep and anterior which makes radical exposure imperative.

Sacroiliac involvement secondary to a neighboring suppurative process is not uncommon and warrants emphasis, particularly from involvement of the lower lumbar vertebrae. This has been observed in about 30 per cent of the latter lesions in this clinic, and may be entirely overlooked unless the possibility of sacroiliac extension is borne in mind. The prognosis in these is usually bad. The lesion may remain "silent" under such circumstances particularly ("sacrocoxalgia fruste" of Delbet). Frequently both joints are affected.

Clinically the extent and location of the lesion is most difficult to determine. Secondary abscesses may further obscure the *x*-ray picture as well as the local physical condition. The onset may be acute or insidious. The rapidity with which signs of retroperitoneal irritation, such as gastrointestinal and genitourinary symptoms, appear, further obscures the local situation.

The differential diagnosis involves a consideration of a wide variety of lesions. A careful history and examination should call attention to the sacroiliac joint. Pain and tenderness in this region is practically always present in some degree. There is no position of relief! Sciatic radiation may accompany this symptom. The pain may be referred to the hip of the same side. It should be remembered that the hip may be involved by direct extension along the ilium or soft tissues. If the hip is unaffected, all its motions will be free except the extremes of flexion and extension, because the former puts tension upon the hamstrings, which is transmitted to the sacroiliac joint, and the latter is restricted by iliopsoas spasm. *The rectal examination is important in detecting tenderness and abscess formations.* A sense of edema or induration over the region is present more often than actual swelling and fluctuation.

X-ray examination usually reveals some degree of destruction but gives little other confirmatory evidence as to the

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type of infection. Because many normal sacroiliac joints demonstrate irregularities, the general opinion seems to be that pelvic region requires a careful consideration of the sacroiliac joint as the possible source of infection. These abscesses usually

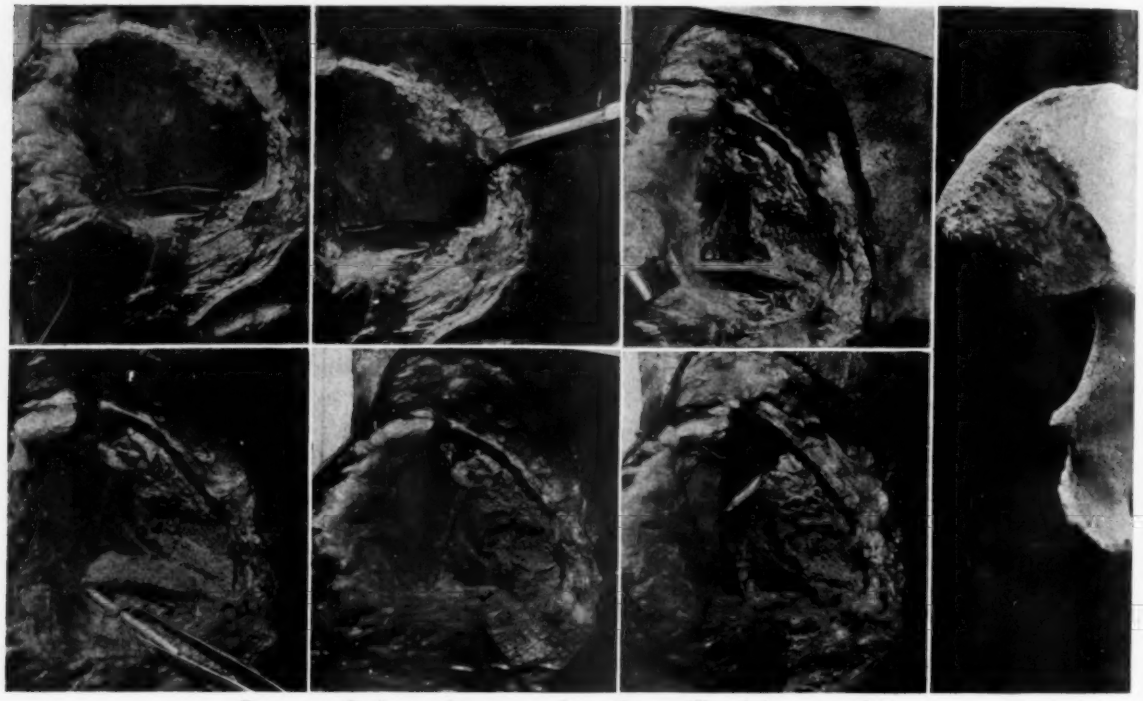

Plate 1. Cadaver demonstration of sacroiliac joint resection.

1. Subperiosteal exposure of posterior iliac flap, and partial resection defined.
2. Chisel driven into joint.
3. Iliac flap removed as in partial resection.
4. Superior gluteal structures beneath periosteum of greater sciatic notch.
5. Ridge of bone above notch removed as in total resection. Entire auricular articulation of sacrum is now exposed.
6. Sacral root isolated from depths of iliopsoas muscle.
7. Relation of anterior margin of joint to lateral border of greater sciatic notch.

interpretation in this situation is especially difficult and confusing. Except in the very young, in which they are superimposed, the anterior and posterior margins of the joint are clearly depicted, the anterior being lateral. In pyogenic involvement one or both are obliterated. When the lesion is unilateral the differences are more striking. The lesion naturally simulates other destructive processes such as tumors and tuberculosis. Lipiodol injection of sinuses will indicate the focus.

Fascial plane abscess extensions of the most bizarre types may develop, and tend further to mislead one as to the site of the original focus. Any sinus about the follow the paths of least resistance which are the fascial planes, but once the fascia is perforated they may spread in unorthodox fashion. It is in such cases that diagnosis is most difficult, but only because insufficient consideration is given the sacroiliac joint. In lesions about the pelvis or their metastatic foci which do not heal following drainage, a primary sacroiliac focus must be ruled out. Similarly recurring metastatic foci should suggest activity of a known primary sacroiliac focus.

Suppurative lesions fo the sacroiliac joint have always been considered as chronic conditions with a grave prognosis.

The chief concern of the surgeon has been for the most part the secondary intrapelvic or extrapelvic abscess which usually occurs here. Primary drainage of the joint focus has received little attention, although radical resection had been adequately described for tuberculous destruction over thirty years ago. This apparent neglect of simple principles of treatment in osteomyelitic involvement of the sacroiliac joint is due to the peculiar deep location of the joint which limits surgical approaches, and the consequent timidity of attack in this region. The following quotation from Martin's recent excellent discussion of osteomyelitis is particularly appropriate for this situation:

I have frequently been unwilling to advise operation in adults with slight persistent lesions without disturbance of general health and with trifling disability where the operation required would demand wide exposure and prolonged incapacity. I have at times been hindered from making suitable exposure by timidity. Fear of spreading infection where the pelvic bones were involved . . . has made me temporize rather than attempt a radical operation.

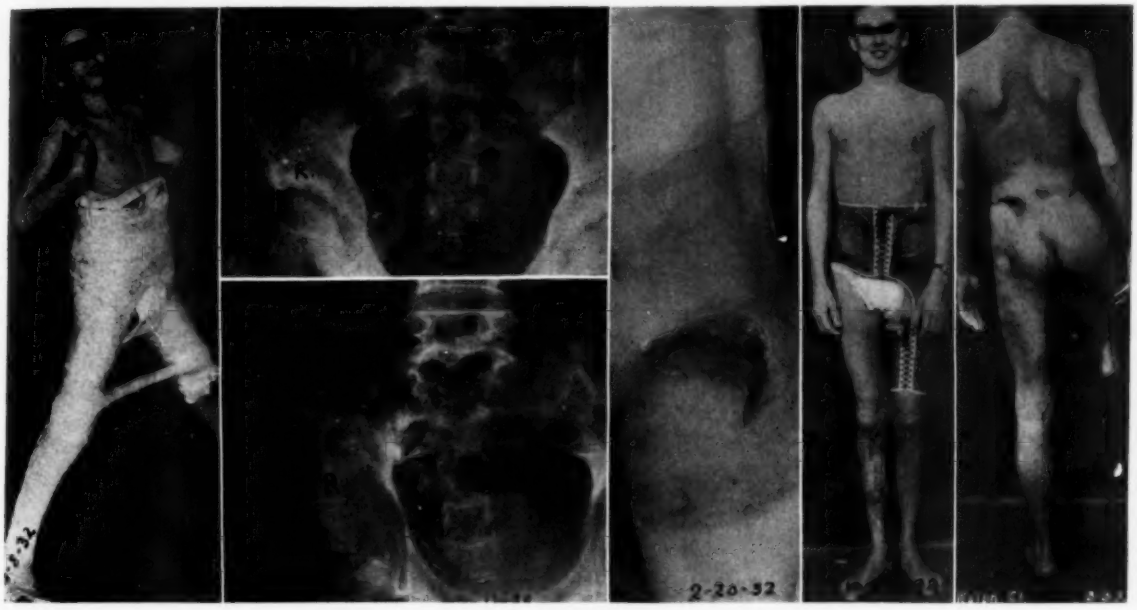

Plate II.

1. Case I. One week after total resection; in usual postoperative double hip spica.
2. Case I. Preoperative *x*-ray: There is destruction of right sacroiliac joint and ilium beyond with several sequestrums; there is already a slight static asymmetry of pelvis.
3. Case I. *X*-ray one year after operation: Definite pelvic asymmetry due to loss of sacral portion of joint; bony parts are apparently fused, and there is a suggestive small sequestrum at lower margin of joint.
4. Case II. Operative sinus two weeks after operation, with vaseline pack removed for photographic recording.
5. Case II. Ambulatory short leather reinforced hip spica, about ten months after operation.
6. Case II. Patient thirteen months after operation.

It therefore seems that the depth of the lesion, the insufficiency of clinical signs and its progressive character show the futility of treatment other than the radical resection.

Bardenheuer, in 1899, was the first to urge radical resection of the sacroiliac joint; in this instance for tuberculous involvement. The technique is essentially a subperiosteal resection of a posterior iliac flap and the sacral portion of the joint. The approach is posterior through a modified Sprengle type of incision. The posterior half of the ilium is subperiosteally stripped on both intrapelvic and extra-

pelvic aspects, exposing the sciatic notch. The ilium is sectioned vertically with a Gigli saw which is passed through the lateral

Smith-Petersen, in 1917, stated that this resection was too radical in any but the most extensive cases, and described his

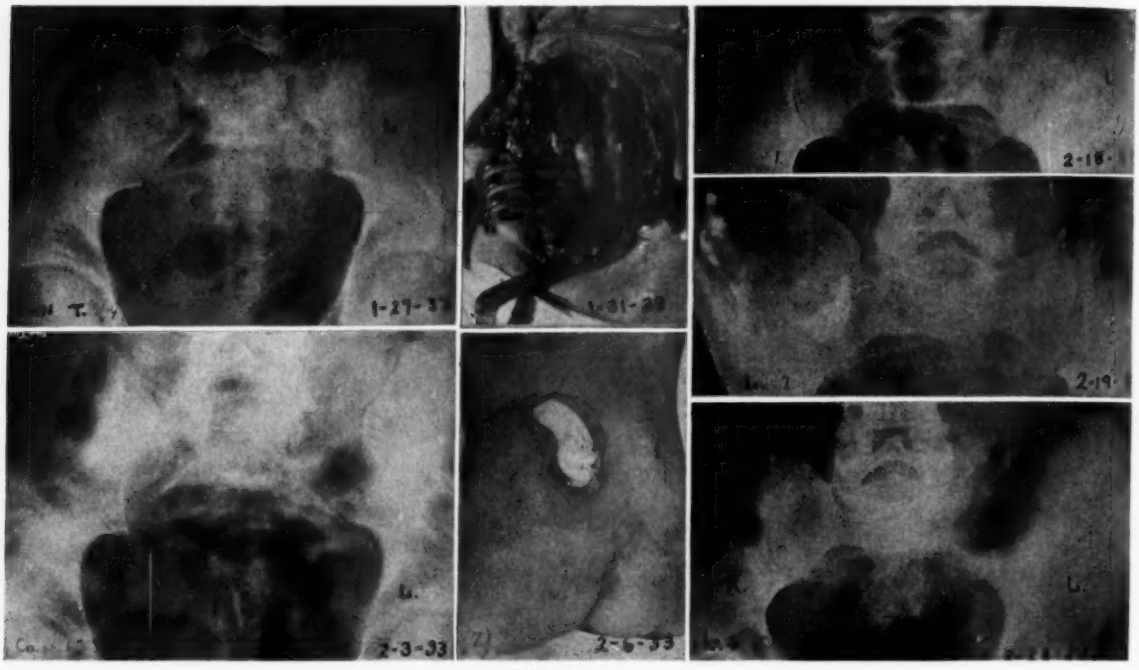

PLATE III.

1. Case III. Preoperative *x*-ray showing destruction of left sacroiliac joint.
2. Case III. X-ray after complete resection of left sacroiliac joint.
3. Case III. Operative field after complete resection.
4. Case III. Operative wound with vaseline pack in place one week after operation.
5. Case IV. Preoperative *x*-ray demonstrating sclerotic lesion of left sacroiliac joint.
6. Case IV. Preoperative lipiodol injection of sinus.
7. Case IV. Postoperative *x*-ray after partial resection of left sacroiliac joint.

border of the greater sciatic notch. His mortality, in 20 cases, was thirty per cent. Schede had done 26 such resections with a mortality of 40 per cent and 10 cures, since 1875.

Painter, in 1908, reported one fatal case following resection. This patient was in a desperate condition due to marked tuberculous involvement of the entire region, and the operation was attempted as a last resort. Nevertheless this apparently discouraged the further development of this procedure in this country.

Picque, in 1909, classically discussed his total and partial sacroiliac resection for tuberculous osteomyelitis of the sacroiliac joint ("sacrocoxalgia"). His technique is based upon that of Bardenheuer, but is somewhat refined.

own ingenious lateral approach to the sacroiliac joint, in which a window is chiselled into the joint through the ilium.

The 4 cases to be reported were treated by the Bardenheuer-Picque technique as it was developed in this clinic. No other instances of pyogenic osteomyelitis of the sacroiliac joints so treated have been mentioned in the literature. The procedure lends itself admirably to the principles systematized by Orr in the treatment of osteomyelitis; and are, namely: adequate drainage of the bony focus, adequate rest and protection of the parts until healing has taken place, and the prevention of secondary infection by the elimination of frequent meddlesome dressings, which such enforced plaster cast immobilization minimizes. This latter will bear special empha-

sis. The prevention of secondary infection is an axiom in surgical tuberculosis. Picque was adamant in its observation. It is no less important in the treatment of osteomyelitis.

OPERATIVE TECHNIQUE

The incision follows through the fibrous origin of the gluteus maximus along the posterior one-third to one-half of the iliac crest, curves downward over the inferior spine, and laterally into and in the direction of the fibers of the gluteus maximus muscle. The ilium is then subperiosteally stripped down to the greater sciatic notch, exposing it. Great care must be observed at this border to avoid injury to the superior gluteal artery which lies directly beneath the periosteum under the notch. Several fatal cases of hemorrhage have been reported from injury to the superior gluteal artery, due to its retraction into the pelvis. Even the soft tissue flap must be gently retracted to avoid unnecessary tension in this region. Bleeding may be troublesome in that it is multiple but will not be considerable from any one vessel. Careful and even unhurried stripping is less conducive to hemorrhage and shock than the vigorous technique which one is tempted to use in order to save time. Careful control of hemorrhage is the most important feature of the entire dissection.

Next, the superior and inferior spines are stripped bare well down upon the sacrum. The crest and intrapelvic portion of the ilium is likewise carefully denuded. All of this makes for an easier removal of the iliac flap, which is the most delicate part of the procedure. The line of resection is defined with the Albee saw, and minimizes shock, especially when the bone is sclerotic. In the partial operation, the heavy ridge of bone just above the sciatic notch is left intact (Plate I, 3). In the total resection the latter is also sacrificed. Initially it is sufficient to do the partial operation, and complete the debridement if the clinical condition indicates it.

In partial resection, the vertical line drops from the crest of the ilium to ½ inch above the lateral border of the sciatic notch. This will direct one to the anterior margin of the sacroiliac joint (Plate I, 7). If a pelvic abscess is suspected, this is planned about ½ inch more laterally, which will expose the posterior pelvic soft structures. The horizontal line of resection meets the lower margin of the vertical and completes the outline of the iliac flap (Plate I, 3). A broad flap chisel is driven into the joint flush with the ilium just behind the spines, downward and laterally (Plate I, 2). The entire bone flap is then elevated by levering, and stripping. Although the ridge just above the notch is thick some care must be observed to prevent its fracture.

Now the sacral auricular articulation is exposed (Plate I, 3). The sacral debridement depends upon the pathology present, and proceeds with the mallet, chisel and curette. The sacral resection proceeds methodically even if necessarily piecemeal. Saucerization down to healthy bone is the ideal attainment, even at the expense of opening into the sacral canal. Bleeding is troublesome but is controlled with hot packs or bone wax. To reach the pelvic abscess one proceeds cautiously between the roots of the nerve plexus. The sacral roots anteriorly are well protected in the substance of the iliopsoas muscle (Plate I, 6). The other important intrapelvic structures are also reasonably well protected by the soft tissues. With the periosteum and the psoas muscle exposed, careful blunt dissection will evacuate the intrapelvic abscess. One will be amazed at the amount of dense soft tissue in this region. The ala of the sacrum permits about one inch of resection before the sacral canal is exposed.

All oozing is now controlled, and the wound is flooded with iodine and alcohol. The wound is preferably left wide open (Plate II, 4) or a few interrupted sutures may be placed at the upper and lower limits of the incision. It is then loosely packed with vaseline gauze (Plate III, 4)

and a generous dressing follows. A double hip spica is applied with the joints in the neutral position (Plate II, 1). If the patient had considerable preoperative psoas irritation, about twenty degrees of flexion on the affected side will insure comfort. This may be changed to full extension in about one week. The cast is changed every one to three months as indicated by the amount of discharge from the sinus. If shock has intervened, the application of the cast is temporarily postponed, and the patient is placed upon a Bradford frame for several days, with the knees slightly flexed. A bivalved plaster spica may be prepared beforehand, or the procedure carried out through a window in the cast applied before operation.

The postoperative care should be under the supervision of the surgeon. All dressings are done under absolutely aseptic precautions. The pack is finally spontaneously extruded. It is surprising how rapidly the operative sinus tends to close due to the abundant soft tissue pad in this situation. Fresh vaseline packs may be introduced from time to time, as indicated but should never be removed for long periods. The drainage is very profuse, and may cause excoriation of the skin (Plate III, 4). This complication is never serious and may be prevented by protecting the skin margins widely with the vaseline gauze strips. The wide open sinus insures adequate drainage with or without the aid of gravity, which facilitates postoperative care and allows frequent changes of the patient's position. The immediate indications for examination of the wound are pain, persistent temperature, or signs of hemorrhage.

Recumbency in the spica continues until the wound is practically healed, or until the drainage is serous and scanty. The general hygienic measures are those observed in the treatment of tuberculosis. Supported weight-bearing is then permitted in a single hip spica for about one month. The patient becomes ambulatory in a short hip spica or reinforced leather hip spica for at least six months to a year after complete healing (Plate II, 5). This gives ample opportunity for regeneration and fixation of the bony parts, especially after a complete resection.

It is evident that any method of treatment that meets with the surgical axiom of adequate primary drainage, adequate rest of the parts and the prevention of secondary infection should be the method of choice. The entire diseased area is under the direct visualization and palpation of the operator. This is not possible in the Smith-Petersen technique which also fails to drain directly any pelvic abscess which may be present. The chief feature of the procedure is to adaptate the degree of resection to the amount of destruction present. The operation is entirely clinical and one works carefully from the surface to the depths until a healthy firm bed of bone remains. The dangers and limitations of the operation are given by Bardenheuer as: possible further extension of the disease process, the occasional impossibility of removing the entire focus, shock due to hemorrhage and prolonged operative trauma and fat embolism. He warns especially against the use of the chisel in the removal of the iliac flap because of one fatal case of fat embolism.

Static deformities need not result from this operation. In Picque's 7 cases, the ilium finally fused to the sacrum as it did in Case 1 of this series. The only contraindication to the total operation would appear to be in young women who might bear children, and in the very young, and in poor operative risks in general. The partial operation interferes less with subsequent growth and maintains the integrity of the pelvic ring. The dense mass of soft tissues about this region as well as the cast prevents any tendency to displacement or herniation. The patient must, in all instances, be a good operative risk. Preoperative general hygiene, blood transfusions, and even preliminary soft tissue drainage are indicated in poor risks. Subcutaneous fluids may be given with advantage during the operation. The

general clinical situation and not the roentgenogram should determine the immediate indication.

Four cases, treated by resection of the sacroiliac joint are reported. All were males; the youngest was fifteen years old and the oldest forty-eight years. In three, the sacroiliac lesion was primary. In only 2 cases did a spontaneous sinus appear. A pelvic abscess mass apparently was associated with all the lesions. In Case 1, an isolated iliac sequestrum was also present. A pelvic abscess was encountered and drained at operation in 3 instances. In the other, the sudden profuse drainage several days later suggests the subsequent perforation of a pelvic abscess into the operative sinus. In 2 cases, moderate shock deferred the application of a cast. In these, discomfort and persistence of temperature continued until a cast was applied. The first 2 cases operated on over one year ago are practically healed. Postoperative complications occurred in 2 cases. In one, several metastatic soft tissue abscesses followed operation. In the last case, a definite subiliacus hemorrhage could be palpated on the second postoperative day. Bleeding from the superior gluteal vein and the sacral canal was troublesome during the procedure. The convalescence was uneventful otherwise in all these cases. The Staphylococcus aureus was recovered in 2 cases, a staphylococcus and streptococcus in one, and no organism in the other.

CASE REPORTS

Case 1. (Plate II, 1–3) L. B. Number F 10,715, white male, aged fifteen years. Primary pyogenic osteomyelitis of the right sacroiliac joint and ilium. Admitted December 16, 1931.

Six weeks before his admission to the hospital, he suddenly developed headache, chills, and a dull aching non-radiating pain "back of the right hip," accompanied by diarrhea and frequency. The temperature was never over 102°F. He had had numerous boils during the summer previous to the present illness.

There was remarkably little external evidence to suggest the seriousness or extensiveness of the lesion. The temperature was 100°F., pulse 80, and respirations 20. There was a suggestive fullness in the right lower abdominal quadrant above the inguinal ligament but no muscle spasm, and very little tenderness. The spinal examination was negative, but a definitely tender swelling was noted over the right sacroiliac region, and all confirmative tests relative to a sacroiliac lesion were positive. The rectal examination revealed a definite tender fluctuating mass at the lower margin of the right sacroiliac joint. The white blood count was 14,200.

Attempted aspiration of the swollen area over the right sacroiliac joint yielded nothing.

Operation (total resection and iliac sequestrectomy): The periosteum of the ilium was found to be thickened, gelatinous and of a dirty grayish color. The bone beneath was injected and roughened. At the junction of the middle and posterior thirds of the ilium just below the crest there was encountered a sequestrum measuring about 3 inches in diameter which was loosely attached and easily removed. This led into a walled off subiliacus abscess area from which about 100 c.c. of thick dirty purulent material were obtained. Several cubic centimeters of thick pus were found in the anterior part of the joint, as well as a small sequestrum. Most of the sacrum was necrotic and no definite line of demarcation between this and healthy bone could be determined.

Comment: He was returned to the ward in good condition. The immediate postoperative convalescence was uneventful. The temperature was normal two weeks after operation. There was absolutely no pain or discomfort. The Staphylococcus aureus was recovered from the pus obtained at operation, and the guinea-pig test was negative. The pathological report was pyogenic osteomyelitis. He became ambulatory about one year after operation, and fourteen months after operation, there is still a slight serous discharge from a small granulating sinus over the sacrum. He has gained considerable weight and has had no exacerbations of symptoms during his convalescence. He cannot yet bear his entire weight on the affected side alone, and is active in

a short hip spica. The extensiveness of the lesion in the joint as well as the iliac focus, both evidencing extreme degrees of necrosis, predicted a prolonged convalescence.

Case II. (Plate II, 4–6.) R. C., Number F 2965, white male, aged twenty-one years. Admitted September 23, 1931. Diagnosis: Metastatic osteomyelitis of the left sacroiliac joint.

Ten days before admission and four years after his initial osteomyelitic lesion of the right tibia, he suddenly developed a dull aching pain in the left groin accompanied by abdominal distention and painful micturition. The temperature remained around 102°F. He appeared acutely ill and septic. The left inguinal glands were enlarged and tender. Numerous old osteomyelitic scars were noted. A tender soft mass could be palpated in the left lower pelvis. There was suggestive tenderness over the left sacroiliac region. These findings plus the *x*-ray examination suggested a possible sacroiliac pyogenic lesion, but his poor condition precluded any but conservative treatment, which was followed by a period of remission. Soon after the gravity of the situation as it recurred made operation imperative. The white blood count was 16,500.

Operation. A partial resection of the left sacroiliac joint was performed, at which time the sacral portion was markedly necrotic. About 500 c.c. of pus were evacuated from the pelvis. There was a moderate degree of shock, and the cast was omitted temporarily.

Comment: Psoas irritation continued for forty-eight hours until the pelvic collection was evacuated, after which the general condition began to improve rapidly. The Staphylococcus aureus was recovered from the pus obtained at operation and the guinea-pig test was negative. The pathological report was osteomyelitis. The convalescence was uneventful save for several metastatic soft tissue abscesses, which occurred postoperatively. One year after operation, the patient is ambulatory in a short leather hip spica. The wound is healed save for a slight granulating sinus from which there is an occasional slight serous discharge. The gait is normal and the Trendelenburg sign is negative on the affected side.

Case III. (Plate III, 1–4.) D. T., Number H 462, white male, aged seventeen years. Admitted January 18, 1933. Diagnosis: Primary osteomyelitis of the left sacroiliac joint.

The present illness began suddenly with some stiffness in the left lower back region which was accompanied by chills and fever nine months before his admission. Four days after the onset, he was confined to his bed for fourteen weeks, with severe sciatic radiation. He lost 28 pounds. Two weeks previous to admission, a spontaneous sinus appeared over the left buttock.

He was somewhat thin and hectic. He walked without support but with a limp. He stood with a definite list of the body to the left. There was bilateral spasm of the lumbar muscles, but very little limitation of the spinal motions. There was definite tenderness over the left sacroiliac joint, and a small granulating draining sinus in the left gluteal region about at the level of the sciatic notch. The hip motions were free. The temperature was 99.4°F., the pulse 100 and the respirations 24 per minute. The white blood count was 11,400.

Operation: A total resection of the left sacroiliac joint was done. A probe passed into the external sinus entered the pelvis just below the sciatic notch. The chief destruction was found in the upper and anterior poles of the joint involving the sacrum quite considerably. The ilium just above the sciatic notch was brittle and apparently involved. Only a few cubic centimeters of pus were encountered in the joint and none in the pelvis. He was returned to the ward in good condition.

His postoperative recovery was uneventful, except for some skin excoriation due to the subsequent profuse drainage. The convalescence was uneventful, and he was discharged in a cast for two weeks after operation.

Comment: No bacterial growth was obtained from the pus encountered at operation. The pathology was osteomyelitis.

Case IV. (Plate III, 5–7.): W. S., Number E 8997, white male, aged thirty-eight years. Admitted February 14, 1933. Diagnosis: Primary osteomyelitis of the left sacroiliac joint.

About two and a half years before admission, he fell over a wheel barrow and bruised his back and left side. A sinus formed below the level of the greater trochanter, followed by two others in the same vicinity three months later. Two months before his first admission to this clinic he was operated upon. He came to this clinic first in January, 1931. He had definite tenderness over the left sacroiliac joidt,

and a sinus just above the mid-point of the crest of the ilium. In January, 1931, drainage was instituted by the Smith-Petersen method, but no frank pus was encountered. The pathological report was osteomyelitis. The Staphylococcus aureus was recovered, and the guinea-pig test was negative. He had a somewhat stormy postoperative convalescence, the operative wound healed in four months, but the original sinus never did. He was never relieved of his discomfort or radiation pain. He returned in February, 1933, willing to undergo another operation, because of the persistence of the original symptoms and disability. A lipiodol injection of the original sinus showed the solution in the pelvis just anterior to the sacro-iliac joint (Plate III, 6).

Operation (partial resection): Considerable adhesions were present and more than the ordinary amount of oozing resulted from stripping the scarred soft tissue flap. The spines of the ilium were roughened and almost fused to the sacrum. A partial resection was done. The entire joint was destroyed, and the ilium was sclerotic and very thick. The sacral portion was necrotic at the level of the third segment and the sacral canal was opened in eradicating this area. The pelvic soft structures were exposed in the depths, and an abscess drained through the iliopsoas muscle. Several branches of the superior gluteal vein were accidentally torn by traction but fortunately could be clamped and ligated, thanks to the wide exposure. A moderate degree of shock prevented the immediate application of the cast.

Comment: This case chiefly demonstrates the inadequacy of the former operation. The value of lipiodol injection of sinuses as an aid to the diagnosis is self evident. The Staphylococcus aureus and streptococcus were recovered from the pus. The pathology was osteomyelitis. The postoperative convalescence was uneventful except for what appeared to be a subiliacus hemorrhage in the left pelvis two days later. Several small transfusions were followed by a marked improvement in the general condition and he was discharged in a cast about one month after operation.

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PHYSICAL THERAPY IN POSTOPERATIVE RECONSTRUCTIVE SURGERY

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IN this paper we shall consider only those modalities of physical therapy which have general application in postoperative reconstructive surgery.

The main objects of postoperative therapy may be listed as:

1. Protection of healing tissues from injury of all sorts until firm, healthy union has occurred. 2. Maintenance of a plentiful blood supply to nourish and aid healing. 3. Adequate drainage of lymph and venous blood from the healing area to prevent stasis, edema and starvation of the grafts or implants. 4. Adequate wound drainage. 5. A sterile wound. 6. A cosmetic and functional success.

Adequate protection is attained mechanically by the various dressings, plaster splints, casts, extension frames, etc., applied by the operator at operation.

The maintenance of active hyperemia is favored by various thermal measures suited to the part. Thus photothermy from incandescent sources may be used for surfaces such as the face or abdomen, and paraffin or whirlpool baths for the extremities. Where dressings are not removable heat may be induced by high-frequency electromagnetic fields. In such cases the increased volume of the limb requires that the dressing permit of expansion without constriction.

In some cases high-frequency sparks from condenser electrodes or the effluve from a de Kraft resonator is highly effective, especially where pain is present.

Massage of neighboring tissue and movement of adjacent joints assists in giving better blood supply. Massage or mechanotherapy should not be applied directly to a healing area for at least three weeks after operation to allow of firm union and to avoid infection.

To remove stasis (edema) nothing can equal, in gentleness and effectiveness, the use of the static brush discharge which may be applied as soon as the patient comes out of narcosis, as it is painless, and by immediately reducing the swelling and ecchymosis relieves the pain of tension and pressure. It is valuable in preventing the tension which pulls on sutures and tends to separate wound edges. It also stimulates sluggish ulcers.

Where a wound cannot be made sterile because of the nature of the condition and its location, photothermy is very helpful as it is antiseptic in effect, though not germicidal. In employing the superficial germicidal effects of ultraviolet radiation, care must be exercised to prevent a marked erythema, because such a reaction causes stasis and stasis starves tissues, thus endangering the life of grafts. Where wounds are irregular, tortuous, deep, with sinuses, we make use of the ions of zinc, silver, copper, iodine or chlorine introduced by the electrolytic current.

A 2 per cent solution of their salts may be used as an immersion electrode into which a limb is inserted or as a moist electrode with absorbent cotton penetrating all crevices or incorporated in modeller's or potter's clay which can be moulded to every irregularity.

Erysipelas can be very satisfactorily treated by intensive ultraviolet radiation. The beneficial results usually manifest themselves promptly and dramatically.

Where functional success requires motion, either voluntary motion directed by the attendant or involuntary motion by manipulation or by electromechanical currents may be used. The prime precaution to be observed is not to exercise to the point of fatigue, nor to exercise healing tissue until firm union is established.

Cosmetic effects call for removal of blemishes such as moles, etc. Electrochemical and electrothermal surgery suffice, except for scars, especially keloids.

Superfluous hair is most satisfactorily and surely removed by cathodal electrolysis, though this procedure is very tedious.

TRAUMATIC AND DEVELOPMENTAL ABNORMALITIES OF THE SESAMOID BONES OF THE GREAT TOE*

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THE anatomical location of the metatarsal sesamoid bones of the great toe renders them particularly liable to the trauma of both direct and indirect violence. Developmental variations in their structure occur frequently and may be the seat of local pain and tenderness following injuries elsewhere in the foot. The 5 cases presented here illustrate the importance of an accurate clinical and roentgenological diagnosis in the analysis of symptoms referable to the first metatarsophalangeal joint.

REPORT OF CASES

CASE I. A. G., a white male, aged twenty-one years, came to the hospital on February 6, 1932, because of tenderness beneath the ball of the right great toe, and pain in this area on walking. Several days previously, while carrying one end of a heavy refrigerator, his foot slipped from the curb to a cement road, producing acute hyperextension of the great toe and direct trauma to the plantar surface of the foot in the region of the first metatarsophalangeal joint. Examination disclosed local tenderness beneath the head of the first metatarsal bone. The foot was strapped with adhesive plaster without relief from symptoms and ten days later roentgenological examination revealed "an irregularity in one of the sesamoids beneath the distal end of the first metatarsal, suggesting the possibility of fracture" (Fig. 1A). A doughnut made of saddler's felt was applied to relieve direct pressure on the sesamoid bones.

The symptoms persisted and after the lapse of one month the patient still had pain with every step, local tenderness, and pain when the great toe was dorsiflexed. A metatarsal bar was attached to the sole of the shoe.

Still no relief was obtained and in May a plaster boot was applied. It was essential for the patient to continue with his job and the plaster was worn for only a week, because of his difficulty in getting about. A thick pad of felt was strapped beneath the arch of the foot and worn for three months. During this period the symptoms partially subsided but never entirely abated. *X*-rays showed no change in the appearance of the lateral, or fibular, sesamoid. Operative removal of the bone was advised and refused by the patient.

He continued to work regularly and was not seen again until October. At that time he still had occasional mild pain when the great toe was hyperextended, and local tenderness to pressure.

The patient returned on January 5, 1933. Two months previously he had purchased a new pair of shoes, one size larger than he was accustomed to wear, and since then had been entirely free from symptoms. Examination still showed slight tenderness to deep palpation beneath the head of the first metatarsal bone. *X*-rays disclosed some absorption of the proximal fragment of the fibular sesamoid (Fig. 1 B). No new bone was apparent.

Comment. This is a case of true fracture of the fibular sesamoid, a rare type of injury. The patient was unable to rest the foot completely and symptoms persisted for a long period of time, in spite of numerous conservative methods of treatment.

CASE II. F. M., a white male aged thirty-five years, came to the hospital on December 10, 1931, because of persistent pain, swelling and tenderness following a sprained ankle. When the injury was sustained several days previously, the foot had been turned acutely in eversion. Examination disclosed local swelling and tenderness over the internal lateral ligament of the right ankle. The foot was strapped in inversion with adhesive plaster.

Four days later, the ankle was improved but the patient complained of pain beneath

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the anterior arch. Examination revealed tenderness under the head of the first metatarsal bone. A felt pad was applied beneath the transverse arch and the ankle was restrapped. After an interval of three days the strapping was removed and the patient was discharged.

A B C D

FIG. 1. Case I. A. and B. Roentgenograms of right foot revealing comminuted fracture of fibular sesamoid. C. and D. Films eleven months later show no new bone.

One week later he returned to the hospital because of persistent tenderness below the distal end of the first metatarsal. *X*-ray plates of the foot were taken and interpreted as follows: "Films of the right foot show the mesial sesamoid beneath the end of the first metatarsal to be in two fragments, each having an irregular margin in the adjoining edges, and but slightly separated. This sesamoid bone has probably been fractured." A small doughnut made of saddler's felt was placed beneath the point of tenderness to relieve the pressure of weight-bearing.

The patient was seen at intervals during the following month and the felt pad was changed. Normal activity was not restricted. The symptoms entirely subsided and he was discharged well on January 20, 1932. An *x*-ray film of the foot on that date showed no change in the appearance of the sesamoid bone.

One year later the patient came in for final observation. There had been no recurrence of pain or tenderness beneath the head of the first metatarsal and examination was negative. *X*-ray films of the foot showed no change in the appearance of the mesial sesamoid which was still bipartite. No new bone was apparent. Films of the other foot were normal.

FIG. 2. Case IV. Anteroposterior and lateral films of both feet, showing bilateral developmental bipartism of medial metatarso-phalangeal sesamoids of great toe.

Comment. There was no direct or indirect trauma to the sesamoid bone. Symptoms referable to the first metatarso-phalangeal joint appeared only after the normal mechanics of the foot had been disturbed by a sprain of the internal lateral ligament of the ankle. An *x*-ray film taken

one year after the accident showed no change in the appearance of the mesial sesamoid and no new bone. In view of these facts, it seems evident that this is a case of developmental division of the medial, or tibial, sesamoid and not a fracture.

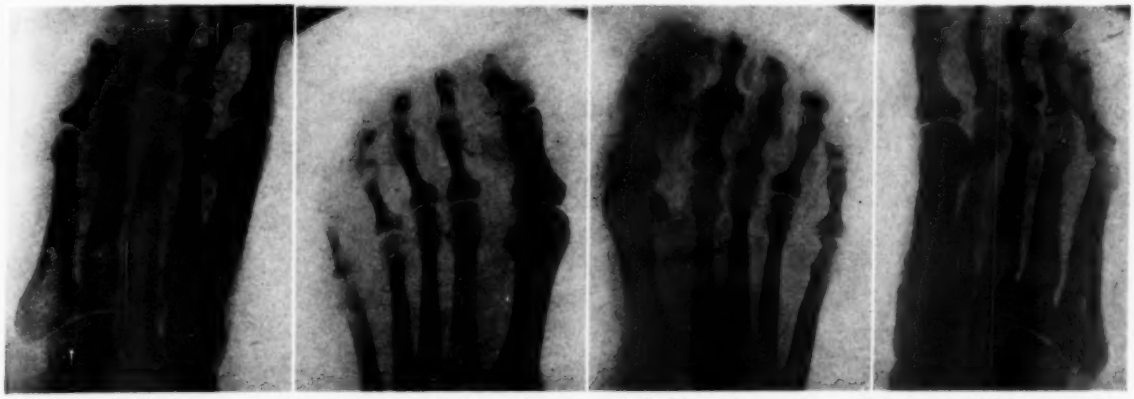

Fig. 3. Case v. Roentgenograms showing bilateral congenital bipartism of medial sesamoid bones of great toe. Note wide separation of segments in left foot as compared with right, and oblique line of division in each.

Case iii. S. S., a white male, aged forty-one years, was seen on January 8, 1932, because of a "sprained ankle." Twenty-four hours previously he had fallen and turned the right foot acutely in inversion. Examination disclosed ecchymosis, swelling and tenderness over the external lateral ligament, and pain on inversion of the foot. *X*-ray films of the ankle revealed no fracture; hypertrophic changes in the tarsus were noted. The ankle was strapped in eversion; ice packs, rest and elevation were advised.

Three days later the pain had disappeared and the swelling and tenderness were subsiding. The patient was allowed to get about with crutches which he shortly discarded for a cane. At the end of a week there was no pain on walking. An elastic bandage was applied and the patient was discharged.

Two months later he returned claiming that he had not been able to resume his usual occupation, that of a butcher, because of failure to regain full function of the right ankle. Examination disclosed no swelling; motion of the ankle was normal. Tenderness to palpation was elicited over the external lateral

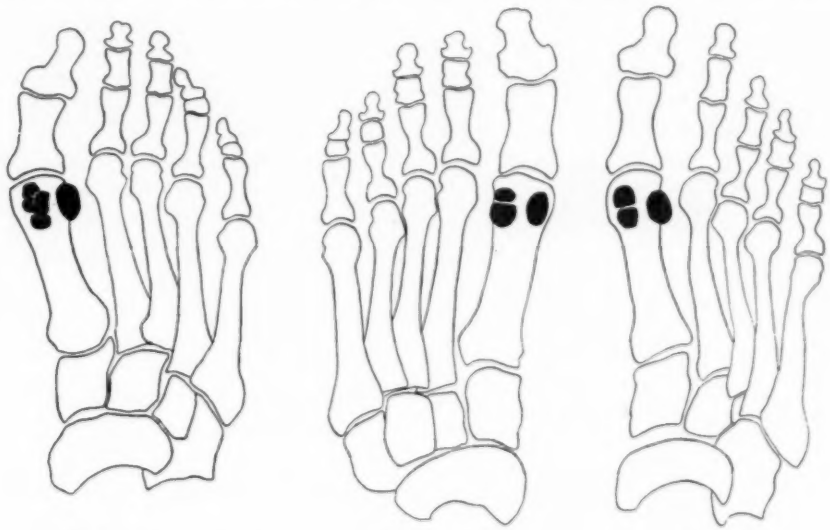

Fig. 4. Fig. 5. Fig. 6.

Fig. 4. Developmental quadripartism of medial sesamoid.
Fig. 5. Congenital division of lateral, or fibular, sesamoid.
Fig. 6. Developmental bipartism of medial sesamoid showing two fragments of equal size with smooth adjacent edges separated by a transverse cleft.

ligament, on the dorsum of the foot just anterior to the external malleolus, and beneath the head of the first metatarsal. Roentgenological examination of the foot showed "apparently a fracture of the medial sesamoid beneath the distal end of the first metatarsal bone." A film of the opposite foot was normal.

In view of the fact that the patient suffered no discomfort beneath the ball of the foot on walking, a protective dressing was not applied. Physiotherapeutic treatments of the ankle were followed by resumption of normal activity in three weeks.

On January 5, 1933, one year after the accident, the patient still complained of occasional swelling and stiffness of the right ankle. There was no pain or tenderness beneath the head of the first metatarsal bone. *X*-ray films of the foot disclosed no change in the appearance of the medial sesamoid. The bone was bipartite; no callus was seen.

Comment. This case represents another instance of developmental division of the tibial sesamoid, misinterpreted as fracture, with symptoms referable to the anomaly appearing incidentally following a sprained ankle.

Case IV. E. R., a white girl, sixteen years of age, was seen March 20, 1932, because of an injury to the right foot sustained the previous evening during gymnastic exercises. The exact nature of the trauma could not be ascertained. Examination disclosed swelling of the anterior part of the foot and marked tenderness, particularly over the first metatarsal bone.

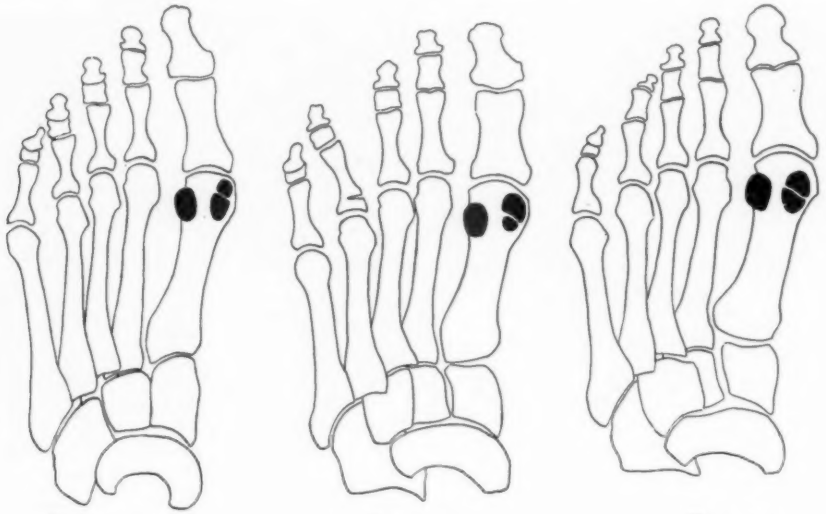

Fig. 7A. Fig. 7B. Fig. 7C.

Fig. 7. Different types of congenital division of the medial sesamoid. A. Distal segment smaller; cleft narrow and oblique. B. Distal segment larger and semilunar in shape; cleft wide and oblique. C. Two fragments equal in size, with rounded corners, and separated by narrow, oblique cleft.

Anteroposterior and lateral films of both feet revealed bilateral developmental division of the medial sesamoid bones (Fig. 2). The foot and ankle were strapped with adhesive plaster, temporary rest was advised, and the symptoms entirely subsided.

The patient was seen ten months later. Films of the feet at that time showed no change in the appearance of the sesamoid bones.

Comment. This case represents the incidental discovery of developmental bilateral medial sesamoids and indicates the importance of taking films of each foot when making a differential diagnosis of symptoms in the region of the first metatarso-phalangeal joint.

Case V. Mrs. A. P., a stout white woman, aged fifty-two years, was seen May 11, 1932, because of pain in the right foot, several weeks in duration. The discomfort was gradual in onset and coincident with a period during which it was necessary for the patient to be on her feet more than usual. Examination showed bilateral pes planus and slight diffuse swelling of the dorsum of the right foot. Anteroposterior and lateral films of each foot revealed bilateral division of the medial sesamoid bones (Fig. 3).

The symptoms subsided following appropriate treatment for flat feet. The roentgenological examination was repeated January 5, 1933, and disclosed no change in the appearance of the sesamoids.

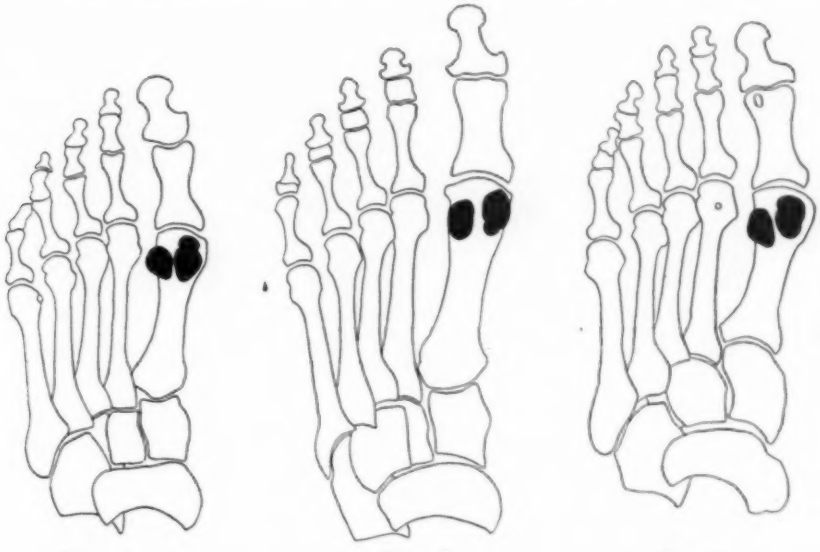

Fig. 8A. Fig. 8B. Fig. 8C.

Fig. 8. Different types of "dumb-bell" sesamoids. It is suggested that these represent intermediate stages of ossification between normal and bipartite bone. A. Compare with Figure 7 A. B. Compare with Figure 7 B. C. Compare with Figure 7 C.

Comment. This represents another case of bilateral developmental bipartism of the medial sesamoid bones, discovered incidentally and unrelated to the presenting symptoms.

ANATOMICAL CONSIDERATIONS

The metatarso-phalangeal sesamoids of the hallux are a constant feature of the osseous structure of the foot. They lie one in each tendon of the flexor brevis hallucis just proximal to its insertion into the first phalanx. The median, or tibial, bone is situated directly beneath the medial half of the head of the first metatarsal where it may be subjected frequently to mechanical trauma; the lateral, or fibular, sesamoid usually extends well beyond the lateral margin of this bone and assumes a relatively protected position in the soft tissues between the heads of the first and second metatarsals. This is particularly true in the feet of civilized races and may account for the infrequency of traumatic lesions of the fibular sesamoid.

The size of the bones is somewhat inconstant. The median is usually the larger and in the adult varies from 12 to 15 mm. in length and 9 to 11 mm. in width. The lateral is 9 to 10 mm. long by 7 to 9 mm. wide.[1] Normally the bones present an oval appearance in the anteroposterior view and in profile, a semilunar shell. The plantar surface of each is convex; the dorsal surface is concave and enters into the structure of the metatarso-phalangeal joint.

DEVELOPMENTAL VARIATIONS

The sesamoid bones are preformed in cartilage and enchondrally ossified.[2] According to Burman and Lapidus[3] ossification takes place about the eighth or ninth year; according to Orr,[1] between the eleventh and fourteenth years. Irregularities in ossification occur frequently, leading to the formation of double sesamoids which may easily be mistaken for fracture. Tripartite and quadripartite bones also have been described.

The author examined films of 100 feet taken at random from the files of the roentgenological department of the hospital

and found anomalous sesamoids in 14 per cent. Fifty-one films were of the right foot and showed bipartism of the medial sesamoid in 6 cases and quadripartism in 1 (Fig. 4). Forty-nine films of the left foot disclosed division of the medial sesamoid 6 times and division of the fibular sesamoid once only (Fig. 5). These figures are in accord with those of Geist[4] who found congenital division 16 times in 100 cases, and are proportionate to those of Burman and Lapidus[3] who observed division of the medial sesamoid 72 times but of the lateral sesamoid only 6 times in a series of 1000 roentgenograms.

The fragments may be equal or unequal in size and are usually separated by a smooth line of cleavage which is either at right angles or oblique to the long axis of the bone (Figs. 6 and 7). In the author's series of developmental anomalies the fragments were more frequently unequal and separated by an oblique line of division.

Cases of partial division were seen which suggest incomplete fusion in the middle of the bone from two peripheral centers of ossification (Fig. 8). These are interesting to compare with the tracings shown in Figure 7 for they also occur with equal or unequal segments and transverse or oblique partial lines of division. They represent stages in the development and ossification of these bones, which are intermediate between the normal single sesamoid and the less frequent bipartite bone. It is conceivable, however, that this "dumb-bell" appearance may be due to an old healed fracture, although the records of these patients reveal no history of trauma in early life. Many of the partially divided bones show an area of rarifaction between the niches, which further suggests that they are developmental anomalies resulting from incomplete ossification rather than the end-results of old traumatic lesions.

TRAUMATIC LESIONS

Fracture of the metatarso-phalangeal sesamoids of the hallux is not common but may occur as the result of either direct or indirect violence. The former is usually due to a crushing injury of the anterior portion of the foot, a fall from a height, or direct trauma beneath the head of the first metatarsal bone. Indirect violence is due to sudden, acute hyperextension of the great toe. Some authors state that fracture of the sesamoid may be produced on the cadaver by acute dorsiflexion and abduction of the hallux.

The symptoms are those of pain on walking, especially at the end of each step when the toes are in extension and the weight is thrown forward onto the ball of the foot, swelling, and local tenderness.

Examination reveals redness and swelling about the first metatarso-phalangeal joint, pain in this area if the great toe be extended, and localized tenderness beneath the involved sesamoid.

The roentgenogram offers the most accurate means of differential diagnosis between fracture and developmental anomaly. Fragments of the traumatic variety are usually irregular in outline, present sharp, jagged corners and adjacent rough or serrated edges. The fragments of a congenitally bipartite sesamoid are oval or semilunar in shape with rounded corners and smooth opposing edges. This is not universally true, however, for one occasionally sees fragments of the congenital type which are widely separated from one another and present rough, irregular adjacent edges. In cases of fracture, a break in the cortical substance may be seen in the line of cleavage whereas in congenital division the cortex is usually continued smoothly around the periphery of each fragment. Comminution of the bone offers definite evidence of fracture. A radiogram of the opposite foot may be of great value in reaching a differential diagnosis.

Freiberg[5] has reported a series of patients with symptoms referable to the first metatarso-phalangeal joint, no history of trauma, and roentgenological evidence of division of the medial sesamoid bone. He states that if the cleft be congenital in type, the symptoms are due to damage of

the fibers which connect the two segments, and concludes that all symptoms are, therefore, traumatic in origin, regardless of whether the division of the sesamoid be due to fracture or developmental anomaly.

TREATMENT

An accurate differential diagnosis between traumatic and developmental anomalies is of considerable academic interest and offers much assistance in prognosis. Regardless of the etiology, however, the treatment is the same, whether the lesion be primarily traumatic or developmental in origin. Conservative measures offering protection, support, and relief from the strain of weight-bearing are indicated. This may be achieved by a doughnut made from saddler's felt and placed around the involved bone, a thick pad of felt strapped to the plantar surface of the foot or a metatarsal bar affixed to the sole of the shoe just proximal to the anterior arch. One of these methods is usually adequate to relieve symptoms due to a developmental anomaly.

True fractures of the sesamoid are much more resistant to treatment and the prognosis should be guarded, for the symptoms are apt to persist for a long period of time. Most authors recommend the application of a plaster boot or excision of the fragmented bone.

SUMMARY AND CONCLUSION

One case of fracture of the fibular sesamoid of the hallux and 4 cases of developmental anomalies of the tibial, in 2 of which the lesion is bilateral, have been described in detail. One hundred roentgenograms of feet, examined to determine the frequency of congenital variations in the structure of the sesamoids, disclosed 13 cases of bipartism and 1 case of quadripartism. Several reproductions of "dumb-bell" sesamoids have been presented as examples of incomplete development, intermediate between the normal single sesamoid and the congenital bipartite bone.

Fracture of the metatarso-phalangeal sesamoids of the great toe is not common but may result from either direct or indirect violence. Developmental anomalies occur frequently, due to irregularities of ossification, and may readily be confused with traumatic lesions. The medial sesamoid is more commonly involved than the lateral.

Symptoms of fracture may be caused by slight trauma to a bone which is congenitally divided. The differential diagnosis is based largely upon the type and severity of the trauma, and the appearance of the sesamoid in the roentgenogram.

Conservative treatment is indicated, whether the symptoms be due to fracture or developmental anomalies. The prognosis for true fractures should be guarded.

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ACROMIO-CLAVICULAR DISLOCATION

ANATOMICAL EXPOSURE OF THE OUTER END OF THE CLAVICLE AND THE CORACOID PROCESS

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DISLOCATION of the outer end of the clavicle is not an uncommon injury. It usually results from a fall upon the shoulder in which the scapula is driven forward and inward, rupturing the ligaments between it and the clavicle. In the less severe types of injury only the superior and inferior acromioclavicular ligaments are ruptured. Severe injuries, however, rupture not only the acromio-clavicular ligaments but also the coraco-clavicular ligaments, the conoid and trapezoid. The integrity of the acromio-clavicular articulation depends upon these ligaments, and is important in controlling circular motion of the scapula over the ribs, and in preventing too great rotation of the scapula backwards and forwards. Too free motion of the scapula following an acromio-clavicular dislocation results in considerable disability of the shoulder joint. In order to prevent this disability operative repair of the ruptured ligaments is often necessary. The exact manner in which the damaged structures are repaired varies with different operators.[1–4] Whatever method is used, however, the region explored through the operative incision remains the same.

FIG. 1. Incision.

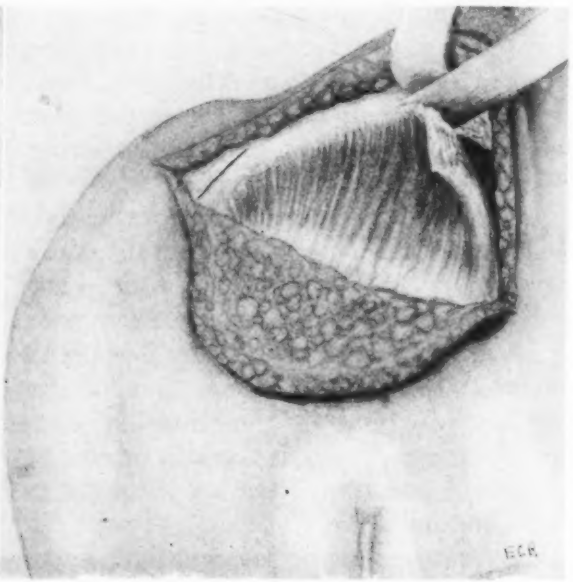

FIG. 2. Separation of deltoid from clavicle.

In order to repair the torn ligaments successfully, the acromio-clavicular joint, the outer third of the clavicle and the coracoid process of the scapula must all be exposed. These three essential regions do not lie in a straight line but at the apices of a triangle. A straight incision running down from the acromio-clavicular joint to the coracoid process cuts the fibers of the deltoid nearly at right angles to their course, the coracoid process lies deep at the bottom of a small hole, and it is difficult to pass a suture of fascia (or other material) around it. Furthermore, retraction of the proximal portion of the muscle must be forcible

in order to expose enough of the clavicle. A slight curve or angulation of the outer end of the incision helps the operative technique

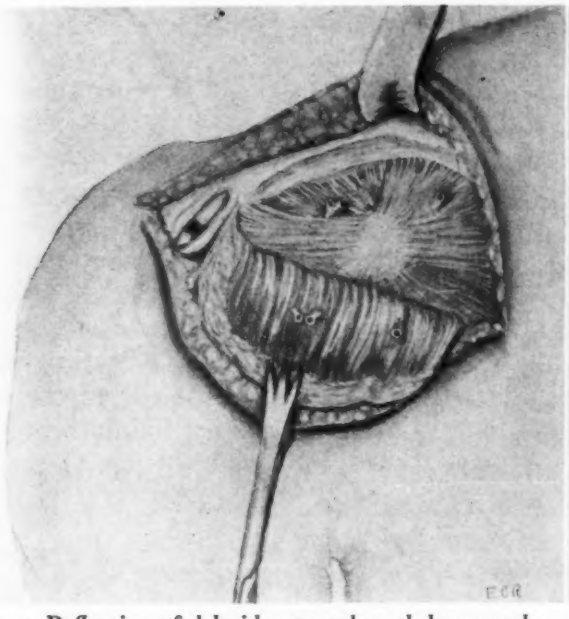

Fig. 3. Reflection of deltoid outwards and downwards.

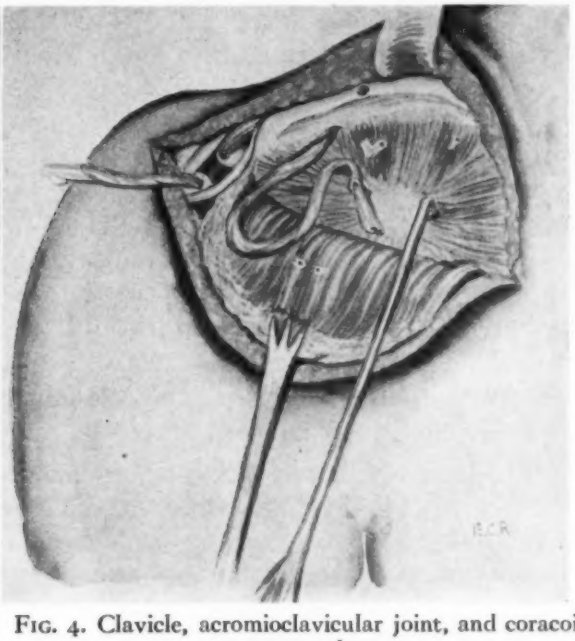

Fig. 4. Clavicle, acromioclavicular joint, and coracoid exposed.

but is still unanatomical in its disrespect for structures. The difficulty in exposing the coracoid is well illustrated by the following quotation:[4] "By retracting the delto-pectoral sulcus the coracoid was exposed, and by retracting *forcibly* it was *at length* isolated." (The italics are mine.) The operation quoted from is of interest in that no fascia or foreign suture material is used, but repair made with the anatomic structures presenting in the wound, namely, the upper fasciculus of the acromio-coracoidal ligament.

The purpose of this paper is to describe an approach to the outer end of the clavicle and the coracoid process that gives full exposure to all the essential regions and which respects anatomical structures, thus minimizing bleeding and facilitating wound closure. The idea of this incision came from Henry's "Exposure of the Long Bones"[5] and the incision is a modification of the upper angle of his approach to the humerus and shoulder joint.

1. A curved skin incision is made starting at the acromio-clavicular joint and running mesially along the outer curve of the clavicle and then turning down to pass just inside of the tip of the coracoid process. The downward arm of the incision follows the sulcus between the deltoid and pectoralis major. The total incision describes a little less than a semicircle. (Fig. 1.)

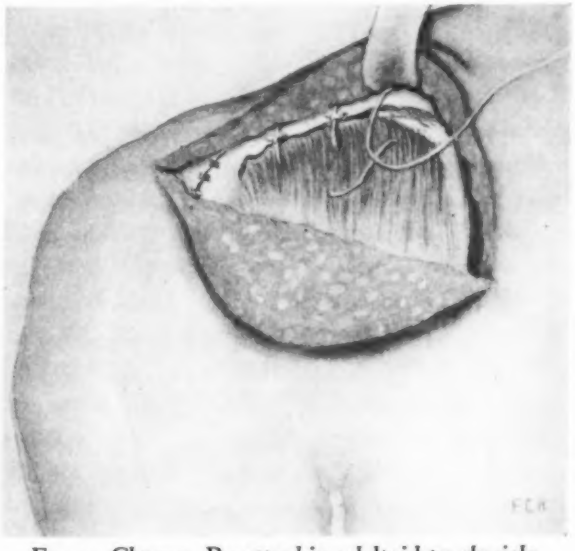

Fig. 5. Closure. Re-attaching deltoid to clavicle.

2. The skin flap is then retracted back, exposing the deltoid muscle. The acromio-clavicular joint can then be exposed by a short incision through the upper part of its capsule. The deltoid is separated from the clavicle either by detaching a small strip of bone containing the muscle insertion (Fig. 2) or else by dividing its semi-tendinous insertion near the clavicle, leaving enough tissue attached to the bone to which to resuture the muscle.

3. The inner border of the deltoid is easily separated from the fatty tissue that lies between it and the pectoralis, and the muscle is then retracted outwards and downwards, thus exposing the coracoid process. The blood vessels entering the muscle from beneath must be cut and sutured, but this is the only point where any bleeding is encountered. The acromio-clavicular joint, the outer portion of the clavicle and the coracoid process are thus made accessible for any repair the surgeon may choose to perform. (Figs. 3, 4.)

4. After repair of the injured ligaments is completed, the deltoid is re-attached to the clavicle by passing two or three sutures through the muscle and around the clavicle. These should be placed before repair of the ruptured ligaments and while the end of the clavicle is still loose and may be lifted up to allow the suture needle to pass close to the under surface of the bone without endangering any blood vessels. When these sutures are tightened the slip of bone containing the deltoid attachment is lashed back into place where it unites firmly. (Fig. 5.)

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RUSTLESS STEEL WIRE IN THE

DIRECT FIXATION OF FRACTURES*

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ALTHOUGH the treatment of fractures is one of the most ancient branches of surgery, open reduction and internal fixation was, of necessity, a development of the century following the discovery of asepsis and the roentgen ray. The first record of internal fixation (Guthrie[11, 15, 24]) credits Lapujade and Sicre of Toulouse with the use of silver wire in 1775. Malgaigne,[22] in 1847, used a metal claw to fix fractures of the patella and this was modified by Chassin[22] for fracture of the clavicle. Dieffenbach[5] in 1845 drilled holes in the ends of fragments and inserted ivory pegs, for the purpose, however, of exciting an inflammatory reaction and acceleration of callus formation rather than for fixation. With the same objective, Pancoast[23] in 1857 pinned fragments together with a drill, left in position and removed after union had occurred. Rigaud is quoted by Conn[3] as having first fixed a fracture (olecranon) with Swedish iron screws.

Unsatisfactory results were the rule during this early period, due to sepsis with osteomyelitis and non-union, and advancement in the operative treatment of fractures failed to keep abreast of improvements in abdominal, pelvic and cranial surgery. In 1895, Lane[19, 21] characterized the current treatment of fractures as a disgrace to surgical practice, and advocated open reduction of simple fractures when a satisfactory result, as seen by *x*-ray, was not accomplished by closed methods. Gould,[8, 9] Estes[6] and Grant[10] were also pioneers in the field of operative treatment of fractures, and were severely criticized for their views by many of their contemporaries in common with others. Heath[13] scored the practice of "converting a simple into a compound fracture," and Sheild[27] favored open reduction only in extreme cases, in the hands of highly skilled surgeons.

The familiar steel plate, introduced by Lane[20] thirty years ago, and at present bearing his name, deserves a prominent place in the long list of non-absorbable devices popularized at various times for the internal fixation of fractures. This list includes wire of silver, bronze, brass and steel; metal bands; bolts, pegs and screws of iron, steel, wood and ivory. In addition, absorbable material, such as catgut, kangaroo tendon, beef-bone pegs and heterogenous bone grafts, has been widely used. Innumerable appliances* have been developed and described as ideal in a voluminous literature. In many instances, however, the results have been disappointing except in the hands of the originator and the use of the device has been short-lived.

Among modern methods of fixation, the vanadium steel plate with special screws used by Sherman[28] undoubtedly promises maximum fixation in a wide variety of fractures, with relatively few disadvantages. The Parham band and fixation with beef-bone pegs and screws have also survived the test of time and have a definite place in selected cases. Recently, the principle of removable interval fixation has been advocated by Carrell and Girard and others,[2] although the merits of the procedure have yet to be proved.

The use of wire has always been recognized as a simple efficient way of securing accurate fixation in the open reduction of fractures, with the introduction of a minimum of foreign material which might

* See Ref. 4, 7, 12, 14, 17, 26, 29, 31.

* Read before the Detroit Academy of Surgery, Ann Arbor, April 13, 1933.

retard union. The disadvantages, however, have been that silver or other non-oxidizing wire was not strong enough to maintain

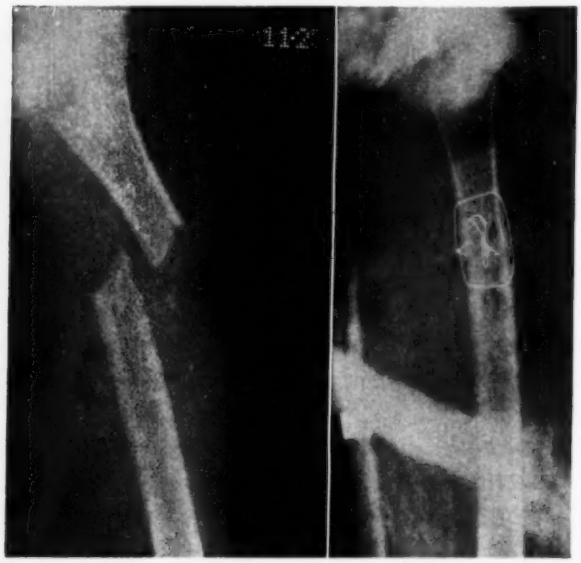

Fig. 1. Fracture through upper third of femur. Fixation by two pieces of wire passed through holes drilled at right angles to each other.

fixation, and steel wire of suitable strength had the common disadvantage of oxidation with reaction about it. Young,[32] reporting fifteen years' experience with fractures, prefers brass wire when wire fixation was indicated, and used this procedure in one-fifth of his cases in which operation was performed.

The use of rustless steel wire for fractures followed soon after the introduction of stainless steel in the manufacture of surgical instruments and equipment. It became popular first in Germany[1] where several reports refer to its use. Janz[16] published excellent results in 140 cases in which rustless steel wire was used, and mentions its tensile strength and durability as points of superiority. Stirling,[30] investigating bone healing, concluded that rustless steel produces practically none of the deleterious effects upon new bone formation which are shown by other metals. The Kirschner piano wire traction apparatus, by employing rustless wire, prevents reaction around the puncture wounds in the skin.[25]

Without entering the controversy regarding the selection of cases, or the varieties of fracture which require open operation, we report a small group in which rustless steel wire[18] was used for fixation, with results which appear to justify the procedure.

MATERIAL

A total of 43 fractures in 38 patients comprised this group; 29 fractures occurred in males and 9 in females. The youngest patient was three and the oldest seventy-six, with the average age twenty-four. The distribution with regard to the bones involved and the type of fracture is shown in Table 1. It may be noted that 33, or

Table 1
CLASSIFICATION OF FRACTURES SHOWING DISTRIBUTION IN VARIOUS BONES

Bone	Simple	Compound	Compound from Osteomyelitis	Total
Femur: shaft	14	..	1	15
Tibia shaft	1	4	..	5
Ulna: shaft	3	3	..	6
Ulna: olecranon	1	2	..	3
Humerus: supracondy	4	..	..	4
Humerus: shaft	2	..	1	3
Humerus: surg. neck	1	..	..	1
Radius: shaft	2	2	..	4
Patella	1	..	..	1
Metacarpal	1	..	..	1
Total	30	11	2	43 (in 38 patients)

76 per cent, were of the shafts of long bones, and that relatively few were of the olecranon and patella. This was a purposeful attempt to evaluate the use of wire fixation in fractures commonly held by plates, pegs and screws.

Thirty fractures were simple, 11 compound from trauma, and 2 compound from osteomyelitis, for which a part of the bone had been removed for drainage, with a pathological fracture resulting. In those compounded from trauma, the time between the fracture and operation varied from one hour to five days. In the entire group the preoperative period of

the fracture varied from one hour to six months, with an average time of 6.1 weeks.

With few exceptions, all simple fractures were given a trial of non-operative treatment before open reduction was thought to be necessary. The methods used were manipulation and fixation; and adhesive, Steinmann pin and Kirschner wire traction. The decision for open reduction was based upon the findings indicated in Table II.

Fig. 2. Compound fracture of tibia. Operation six hours after trauma. Two loops of wire were passed around shaft.

In general, the operative technique was the same in all cases. A suitable approach was made to the fracture site, the fragments freed by subperiosteal dissection and secured by the method which appeared to give the strongest fixation with the minimum trauma. Some, with sufficient obliquity of the fracture line, required only loops of wire passed around the bone, while in others the fragments were best held by one or more wires passed through drilled holes. For transverse fractures in the shafts of long bones such as the femur, two wires passed through holes drilled at right angles to each other provided accurate approximation of the fragments with the introduction of very little foreign material for strong fixation (Fig. 1). Plaster casts were used in most cases for immobilization.

Fig. 3. Non-union of both bones of forearm. Solid union occurred after fixation with wire, with full range of motion.

Table II

Condition which necessitated operative interference, and preoperative duration

Malposition	21
Malunion	3
Delayed or non-union	6
Compound (trauma)	11
Compound (osteomyelitis)	2
Total	43

Average preoperative duration of all fractures 6½ weeks.

Pathological fractures from osteomyelitis, as well as those compounded from trauma in which the time interval precluded primary closure, were packed with gauze and the Orr principle used, i.e., plaster fixation and infrequent dressings. The presence of the wire did not appear to

exert any deleterious effect upon the formation of callus or upon the granulations covering it, and union was prompt in all except one case. In this there was a marked loss of the tibial shaft from debridement, and non-union resulted.

Fig. 4. Non-union occurring in upper end of tibia. Prompt solid union followed direct fixation by two loops of wire passed through drilled holes.

RESULTS

An excellent anatomical and functional result was obtained in 85 per cent of cases while in 10 per cent the result was classified as "good." Many of the latter group failed to have a perfect end-result however, only because of some loss of motion of a joint or slight angulation rather than because of any important imperfection in the principle of wire fixation. "Fair" and "poor" results were found in 3 per cent and 2 per cent respectively. Among the "poor" group was a pathological fracture of the femur (osteomyelitis) with non-union, and an extensively comminuted compound fracture of the tibia, with marked loss of bone (already mentioned).

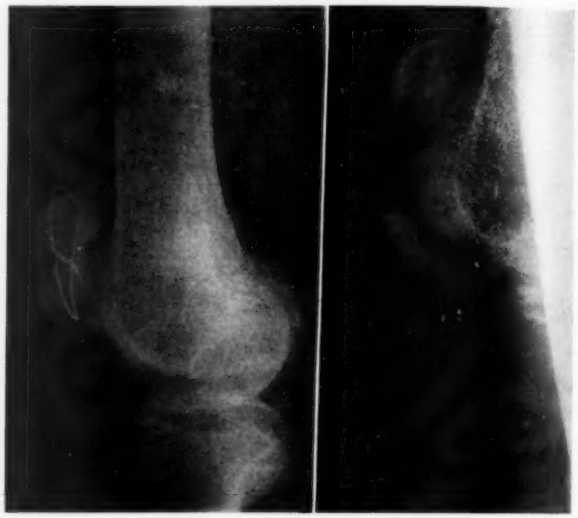

Fig. 5. Transverse fracture of patella with wide separation of fragments. One loop of wire secured good approximation and permitted early flexion of knee.

Gradual loosening of the cast permitted some angulation to occur in several fractures through the shaft of the femur following operation, but in no case did the wire break or fail to maintain fixation, and the angulation was easily corrected by wedging the cast.

In but 6 of the 43 fractures has it (so far) been necessary to remove the wire, although others may in the future require it, since the oldest of this series is slightly over three years, the most recent but a few months. In 2 cases with pathological fracture from osteomyelitis, persistent sinuses remained, and the wire was removed together with sequestra several months after its insertion, after firm bony union had occurred. In 2 compound fractures in which osteomyelitis and delayed or non-union developed, it was also thought best to remove the wire. Both of these occurred in the tibial shaft. The other 2 cases in which the wire was removed were (1) from a metacarpal because of a fancied disturbance in the sansation of the palm of the hand, and (2) from a fracture of the shaft of

the femur, for which no reason could be found from the record. In all of these the wire at the time of removal showed no evidence of oxidation, disintegration or staining, although in 3 cases it had been in contact with infected bone for several months.

SUMMARY

Fixation with wire was one of the earliest methods used in the operative treatment of fractures. Silver, brass and copper, as well as many varieties of steel wire have been used, all of which have had disadvantages.

Rustless steel wire provides a simple and efficient method for the internal fixation of fractures, with few objectionable features. It is easily applied in various ways; is not oxidized in either closed or open wounds, and assures maximum fixation of the fragments with the least possible amount of metallic substance introduced into the fracture site.

The use of rustless steel wire fixation in 43 fractures of several bones demonstrates the wide scope of applicability of this procedure, and recommends it as a valuable adjunct in the operative treatment of fractures. In no case was there any evidence that the presence of the wire had retarded the deposition of new bone or had interfered with prompt and solid union.

The functional and anatomical end-results in 43 fractures occurring in 38 patients, in which rustless wire was used, were "excellent" in 85 per cent, "good" in 10 per cent, and "fair" and "poor" in 3 per cent and 2 per cent respectively.

Removal of the wire after union has occurred is unnecessary in most cases.

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PERSISTENT AND RECURRENT POSTOPERATIVE EXOPHTHALMOS*

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THE cause of recurrent symptoms following operations for exophthalmic goiter has not been fully explained. Various theories, as well as carefully conducted studies along this line, have been reported, but as yet no satisfactory reasons have been established, why in an occasional instance recurrence of hyperthyroidism takes place at varying intervals following thyroidectomy. It is true that in many cases incomplete removal of the gland, such as in hemithyroidectomy or in instances in which retrotracheal extensions are overlooked, that the cause of recurrence of the goiter can be definitely traced yet there remains a certain definite group of patients in which minimal amounts of gland tissue are preserved and yet return of symptoms is noted.

Classification of these recurrences, therefore, can readily be made on the basis of whether the previous removal of the gland was adequate or inadequate, and of course the proper treatment in the latter type of case is prophylaxis. This consists in a thorough removal of the gland, including the isthmus and also the pyramidal lobe if present, leaving only a thin layer on the posterior capsule and taking care to locate and resect any retrotracheal extensions. This procedure will prevent most, but not all recurrences, and it is in this latter type of case that one cannot attribute a return of the goiter to inadequate or incomplete surgery.

In an analysis of 1683 cases of thyroidectomy for exophthalmic goiter at the Mayo Clinic, Pemberton found recurrences in only 2.9 per cent and in Noguchi's series of 800 instances, there were 5.3 per cent in which the goiter returned. deQuervain states that about 4.5 to 6 per cent of all goiter operations are for recurrences, so it is evident that this problem is a very real one. Clute and Veal followed 97 patients for a number of years, and found that in 4 of these, some toxicity still persisted, but these individuals were able to work and further surgery was not undertaken. They emphasize the fact that some degree of toxicity is present postoperatively in 6 to 10 per cent of all thyroidectomies for exophthalmic goiter, which at times is so mild as to be negligible and at others so severe as to require reoperation.

The amount of gland tissue left behind obviously cannot be estimated to a very exact degree. If this were necessary, then good results from thyroidectomy would be few and far between, because the surgeon would have to possess either extremely accurate methods to judge this amount or he would have to have great intuition to know how much tissue was to be preserved. In other words, most cases of thyroidectomy would result in either postoperative myxedema or persistent hyperthyroidism unless a very definite exact amount of tissue were left behind.

It seems then from evidence obtained by observations of these recurrent cases, that the gland tissue which is preserved regains the power of regulating the function for which the thyroid is responsible, and it can meet demands made upon it so that an apparently normal response takes place. The large proportion of cures in exophthalmic goiter gives strong evidence of this fact. As Pemberton and others have emphasized, thyroidectomy breaks a link somewhere in the chain of endocrine func-

* Presented before the University of Minnesota Medical Alumni Association, Oct. 28, 1932

tions, so that a normal balance between these organs is usually restored. He also points out the fact that in about 40 per cent of these cases of recurrent hyperthyroidism, some predisposing etiologic factor seems to be present, such as colds, influenza, overwork, worry, fright, shock, pregnancy, or operations. However, as to their actual significance there is some doubt.

In only a few cases a partial return of some of the signs of hyperthyroidism is present and it is in these cases especially that therapeutic measures fail. In a certain group of cases, exophthalmos, frequently hardly noticeable preoperatively, becomes more and more progressive following removal of the gland, so that permanent damage seems a likely factor in the production of these changes. The pathologic change responsible for this condition, as determined by Naffziger and Jones, is of mechanical origin, and as described by them is the result of pronounced swelling of the extraocular muscles to from three to eight times their normal size. They recommend for these cases of progressive exophthalmos following thyroidectomy, removal of the roofs of the orbit through bilateral frontal bone flaps.

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Fig. 1. Case I. Exophthalmos first appeared twenty-seven months after thyroidectomy. Eye signs were not accompanied by any other symptoms of hyperthyroidism. Since then ocular prominence has been unilateral but has shifted from one eye to the other.

Fig. 2. Case II. Typical exophthalmic type of goiter with cure of disease for three years after thyroidectomy. Progressive prominence of eyes then reappeared and was definitely benefited although not cured by ligation of inferior thyroid arteries.

Fig. 3. Case V. No change in left-sided exophthalmos for five years after thyroidectomy in spite of disappearance of all signs of toxicity following operation.

Fig. 4. Case VI. Recurrent hyperthyroidism after ligation of superior poles and which persisted in spite of almost complete removal of thyroid gland one month later. Regeneration of a nodule of tissue took place in two and one-half months and was accompanied by marked symptoms of toxicity.

CASE REPORTS

The following case falls into the group just described, showing gradually increasing exophthalmos following thyroidectomy:

Case I. A man, forty-seven years of age, first became ill in February, 1927. At this time he lost 35 lb. in weight within five weeks. He was nauseated a great deal and he frequently vomited. His general strength rapidly decreased and he was soon unable to do any work. He had been treated without much success for diabetes mellitus for the preceding six months.

On examination he was found to be fairly well nourished in spite of his rapid weight loss. His pulse varied from 90 to 100 beats per minute and his blood pressure was found to be 104 mm. Hg systolic over 62 diastolic. There was no exophthalmos nor other eye signs of hyperthyroidism at this time. The thyroid gland was not appreciably enlarged

and no nodules were present in it. A marked tremor of the fingers as well as a decided weakness of the quadriceps group of muscles was noted. Basal metabolic rate at this time was 36 per cent over normal, but after a period of ten days of lugolization it fell to plus 10 per cent.

Thyroidectomy was done on March 29, 1928, and pathologic examination of the tissue removed disclosed a typical exophthalmic type of goiter. Convalescence was uneventful, he rapidly recovered his usual weight and strength, and for the next year he was perfectly well. However, twenty-seven months post-operatively he noticed that his right eye was gradually becoming more and more prominent, but during this time the left eye remained normal. In the prominent eye his vision was very poor and there was a marked degree of conjunctival inflammation, but no ulcers were present. The right eye continued to protrude for about six months when for no apparent reason it began to recede, and concomitant with this recedence of the right eye exophthalmos began to appear in the left eye. Since that time the left eye has remained very prominent until a few weeks ago (October, 1932), when it started to recede somewhat, and again at this time the right eye began to become markedly exophthalmic. His health has otherwise been fairly good although he says he is not up to par physically. His weight is normal and he has no definite complaints except he does not seem to be able to regain his former strength.

Examination at the present time is essentially negative except for marked exophthalmos on both sides, but decidely more marked on the right. The basal metabolic rate was found to be 19 per cent below normal (October, 1932). (Fig. 1.)

Case II. A woman, forty-three years of age, came for examination in May, 1932. Her past history as well as her family history were irrelevant. She had had a thyroidectomy in October, 1928 for exophthalmic goiter following which she recovered her normal health for three years. Her eyes prior to this operation were markedly exophthalmic but they receded and appeared normal within six weeks after the removal of the thyroid gland. In the fall of 1931 she began to have recurrence of her exophthalmos, first in the left eye but soon followed by that in the right, and this was not accompanied by any other signs of hyperthyroidism. Her weight remained normal, she was not nervous, her pulse was not elevated and her general health continued to be excellent.

Physical examination in May, 1932, showed essentially a normal healthy woman but with extremely marked exophthalmos on both sides. No thyroid gland tissue could be palpated. A basal metabolic rate was reported as being within normal limits. Ligation of the inferior thyroid arteries was performed May 27, 1932 following which the condition of her eyes improved. They became definitely less prominent, vision subjectively was better and she noticed that the chronic inflammation in the conjunctiva gradually disappeared. However, at the present time exophthalmos is still marked in both eyes as illustrated in Figure 2, but she otherwise is in excellent condition. Basal metabolic rate at the present time was reported as 3 per cent below normal (October, 1932).

The following case represents a very mild type of recurrence of symptoms four and one half years postoperatively, but not of sufficient severity to warrant secondary operation.

Case III. A woman, twenty-seven years of age, began to have symptoms of hyperthyroidism in December 1926, consisting of extreme nervousness, excitability, insomnia, tachycardia and palpitation of the heart. When she came for examination in October, 1927 she had lost 20 lb. of weight in spite of a ravenous appetite, there was a marked tremor of her fingers, and her quadriceps group of muscles showed definite weakness. Her pulse was regular with a rate of 174 beats per minute, and her blood pressure was 108 mm. Hg systolic over 68 diastolic. A basal metabolism test at this time was reported 35 per cent above the normal. Thyroidectomy was done October 4, 1927 after a period of five days of lugolization. The gland was found to be enlarged to two or three times its normal size, and microscopic examination of the tissue removed disclosed the typical appearance of exophthalmic goiter under treatment with Lugol's solution. After the operation she regained her usual strength, her weight rapidly returned to normal and all of her symptoms disappeared

until eighteen months ago, when she again noticed insomnia, nervousness, tachycardia, palpitation of the heart, tremor of the fingers and slight loss of weight (10 lb.).

On examination in September, 1932, she appeared to be somewhat stimulated, her pulse rate was 84 beats per minute, her blood pressure was 110/84. There was a slight tremor of the fingers and her basal metabolism rate was reported to be 18 per cent above normal.

The following case occurred in a child and presents a very unusual sequence of events. Toxic goiter in a child is rare but when followed by recurrence after surgical removal is of sufficient rarity to warrant detailed description.

Case IV. This patient was a child of twelve years when first seen in 1917. One year prior to this time she had noticed a gradual enlargement of her thyroid gland which caused considerable difficulty in swallowing and breathing. Partial thyroidectomy was done in October, 1917 leaving behind only a small portion of each lateral lobe. The patient returned three years later, with a well-developed exophthalmic type of goiter which was of a fairly severe degree. The superior poles of the thyroid gland were ligated and immediate improvement in her condition was noted.

Her health was then excellent and no further symptoms of hyperthyroidism were present until fifteen months later (January, 1922), when they again reappeared. Basal metabolic rate at this time was found to be 41 per cent above normal. Marked exophthalmos was also present at this time. Thyroidectomy was again done and the patient has remained in excellent health since (October, 1932).

Case V. A woman, thirty-nine years of age, first came under our observation May 3, 1926. For three months prior to this time she had been losing weight (32 lb.), her strength was markedly decreased, she was very nervous, her heart beat very rapidly and she was frequently nauseated. Her appetite was good but occasionally she had vomiting spells. Several weeks after the onset of these symptoms she first noticed a marked bulging of the left eye which continued to the point of impairing her vision on this side.

On examination the patient was markedly stimulated. The blood pressure was 160/58; pulse 130. There was marked unilateral exophthalmos of the left eye along with other signs of hyperthyroidism. There was severe quadriceps weakness and a definite tremor of the fingers. The remainder of the examination revealed no further findings of note. Lugol's solution was prescribed for the purpose of preparation of the patient for surgery but she disappeared and was not heard from until the following November. She had improved rapidly with the disappearance of all symptoms except the unilateral exophthalmos for a period of several months, but a few weeks before her return she had again noticed a gradual reappearance of her former symptoms. A basal metabolic rate determined at this time was found to be 33 per cent above the normal as measured by the DuBois method. Thyroidectomy was performed November 16, 1926, and her convalescence following the operation was uneventful. She gradually recovered her usual weight and strength in a period of a few months, and except for slight exophthalmos on the left side, her physical examination revealed nothing of note. Basal metabolic rates on a number of occasions from the time of the operation until the present time (six years) varied from 8 per cent below normal to 6 per cent above normal and she has had no signs or symptoms of hyperthyroidism except persistent exophthalmos of a mild degree on the left side.

At the present time (October 15, 1932) examination reveals no change from the findings as just noted. Her weight has returned to normal (145 lb.), she eats and sleeps well and in general is in good condition. (Fig. 3.)

Case VI. A girl of twenty-three years first became ill in November, 1931. At this time she had a fairly severe attack of so-called "influenza" from which she did not seem to be able to recover completely, her general health and strength remaining under par. The following February she began to notice difficult breathing, palpitation of her heart on slight exertion, nervousness, loss of weight (19 lb. in four months), and prominence of the eyes. On examination at this time she presented the typical findings of exophthalmic goiter. A basal metabolic rate was found to be 74 per cent above normal. Lugol's solution was given and she improved considerably for a short period of time but her symptoms

recurred in a few weeks in spite of large doses of the iodine compound.

Because of the marked toxicity present, ligation of both upper poles was done April 6, 1932 following which marked improvement in her condition took place for two or three weeks. She gained 4 lb. in weight, her pulse rate came down to 90 beats per minute and she felt much better generally. However, by the first part of May, 1932 she again presented the signs and symptoms of hyperthyroidism with exophthalmos. The basal metabolic rate at this time was found to be 28 per cent above normal. Thyroidectomy was done May 6, 1932 first ligating both inferior thyroid arteries extrafascially, followed by resection of all but a thin layer of the gland tissue on the posterior capsule. Convalescence was normal but the patient since the operation has continued to have symptoms of hyperthyroidism which have persisted more or less unchanged until the present time. Her basal metabolic rate is now 38 per cent above normal and a nodule about 5 cm. in diameter has appeared in the left lobe of the thyroid gland in the last few weeks. This recurrent nodule no doubt represents a regeneration of tissue from glandular elements previously present. (Fig. 4.)

SUMMARY AND CONCLUSIONS

1. The incidence of recurrence of hyperthyroidism following thyroidectomy varies from 3 to 6 per cent. Reappearance of symptoms is not due to inadequate surgery in a large proportion of these cases, although in some instances it follows incomplete removal, such as an overlooked retrotracheal extension of the gland, etc.

2. The amount of the gland to be removed varies in individual cases, but as a rule only a thin layer of thyroid tissue on the posterior capsule should be preserved. It is probable that preservation of only small amounts of tissue is necessary, and even though such an amount would be inadequate under normal conditions to meet the demands of the body, yet this small amount is apparently enough to regenerate even to the extent of causing hyperthyroidism. This is especially true when certain stimulating influences are present such as occur in hyperthyroidism.

3. In the first case there was a definite hyperthyroidism without exophthalmos preceding resection of the thyroid gland but postoperatively there has been unilateral prominence of the eyes which has progressively affected alternate sides. Furthermore, no other toxic symptoms have been present since the operation. The second case exhibited a recurrent exophthalmos which did not appear until three years after the glandular resection and the recurrence was not accompanied by any other signs of hyperthyroidism. The third case can be classified as one of a true recurrence of toxic symptoms after complete freedom from the disease for a period of three and one-half years. The fourth case represents hyperthyroidism in a child in which ligature of the upper poles of the thyroid gland resulted in arrest of the disease for fifteen months. Thyroidectomy was then necessary for recurrence of symptoms and this procedure resulted in permanent cure. In the fifth case exophthalmos of the left eye was unaffected by thyroidectomy although other toxic symptoms were removed by this procedure. In spite of adequate surgical removal in the sixth case, consisting of ligation of all four arteries and resection of the gland, rapid regeneration of thyroid tissue took place postoperatively to the extent of producing hyperthyroidism persisting from the time of operation with gradually increasing severity.

It would seem from this study that there are a number of types of recurrent symptoms of hyperthyroidism, the therapy of which is a difficult problem. In a certain group of patients it is possible to submit these individuals to further resections of the gland, yet in others with no toxic symptoms this procedure is usually of no avail. In the group with mild recurrent symptoms, no treatment is necessary. In one case in this series recurrent exophthalmos was materially benefited by ligation of the inferior thyroid arteries.

[For References see p. 345.]

HYPOTHYROIDISM

ITS RELATION TO CONVALESCENCE RATE AND END RESULT FOLLOWING SURGERY*

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THE surgeon is often asked: "How long will it be after I am operated before I am as strong and well as I am going to be?" In order to answer this question the time estimate that is made is based upon a number of factors. A person in good health, for instance, who needs mechanical repair only, such as a herniotomy or plastic work, will require less time in which to recuperate to the fullest extent than will one who presents a pathological condition with general ill health resulting therefrom. More specific factors in connection with pathology, if present, are the tissues involved, the extent of it, and the time the condition has existed. Other factors also important are the operation itself, that is the nature and extent of it, and of course, the skill of the surgeon and the judgment that was exercised. The patient's age, the type of constitution, the general condition, as for example, the state of the reno-cardio-vascular system and so on, and last but not least, the state of the nervous system are all factors to be considered.

This brings us up to the postoperative care and management. These should not be limited, as is the custom, to the period covered by the patient's stay in the hospital. Lack of sufficient postoperative care is, in the opinion of the writer, responsible to a great extent for the surgical half-cures that we see altogether too frequently. The postoperative care and management should include, if it is not prohibited by one's practice covering too large a territory, a follow-up plan for a period variable in time dependent upon the conditions at hand. For example, a patient in good health with a stable nervous system, who has had simple repair work only, or say, an operation for acute appendicitis without complications, or an interval appendectomy, will be back to normal in three, four or five months. In the majority of surgical cases complete recovery takes about a year, or in some cases two years. During this period a patient should, perhaps, be advised about his food, about the value of sunshine and of being out of doors, and especially about the matter of rest. Additional disease may need to be taken care of, and in many instances the patient himself needs painstaking and persistent management with especial reference to neurotic elements of one kind or another. Details of the management cannot be gone into in this paper, but suffice it to say that when a patient is finally dismissed he should be in as good condition as is possible for him.

Assuming then that all the measures just noted have been carried out to the fullest extent, we come to the question of *hypothyroidism* and what it has to do with the convalescence rate and end result following surgery. The significance of it all is that patients with diminished thyroid secretion do not convalesce so rapidly after surgery, other things being equal, as do those who have normal thyroid action. More than that, patients with a so-called high-normal thyroid function convalesce unusually rapidly.

Three cases will be cited briefly to bring out these points.

About a year and a half ago, during the course of follow-up management of a case in which the patient operated on a year before for a carcinoma of the breast, the convalescence was noted to be very slow. The patient was

* From the Grand Rapids Clinic.

forty-nine years of age. She was not robust, but her previous health had always been good. She had been accustomed to doing her own housework; besides this she had a number of outside interests in which she had been quite active. A year had passed since her operation, and she still continued to complain of feeling tired and fatigued. There was no return of ambition; she had to drive herself to her tasks; she lacked "pep," as she stated it, and everything seemed like a job to her. The tired feeling she complained of was not because she had been doing too much, as is frequently the case. She had done practically no work at all. The appetite remained poor, although she had been out of doors a great deal. The de-energizing processes were out of keeping, it seemed, with the trauma that had been *imposed*. What factors then other than the trauma entered into the delay in the return of energy? There was something about her appearance as well as her complaints that finally suggested the lack of thyroid activity, and this hint was followed up by prescribing thyroid extract, grains ii, daily. The result was almost immediate. A pick-up was noted by the patient after a few days of medication. In a month's time she was doing her own work again. Her interest in outside activities had returned; the appetite was again quite normal, in fact, she felt quite like herself again.

A good case for comparison, because it is also one of carcinoma of the breast in which a radical operation had been performed, is that of a woman fifty-five years of age, who had all the earmarks of having a high-normal thyroid. She had rather snappy, bright eyes and a moist skin, and what is very important, the intensity of the heart action suggested a slight degree of overaction which is indicative of an active thyroid. In less than two months from the time of her operation she had resumed her household duties, doing all her side and arm would permit, and this without causing fatigue. As far as she could tell she was just as strong and vigorous as she had been before her operation.

A very recent experience with thyroid administration is of undoubted significance, at least in the opinion of the writer. It is the case of a woman patient who has just been dismissed from the hospital after a two stage operation for carcinoma of the rectum. When she first came for her trouble ten weeks ago she was regarded as a poor surgical risk because of apparent lack of vitality. Thyroid medication was started five days after the first stage of the surgery, and it was continued during her stay in the hospital. The dosage was 3 grains daily of the desiccated thyroid extract. It would not be enough to say that the convalescence was unusually satisfactory; it was astonishing to everyone to see the change that had taken place in this patient. When she left the hospital her mind was alert and active, her eyes bright and her color better; she had gained weight, and she stated that she was feeling better than she had for a year and a half prior to her operation. She said, "I felt dead during this year and a half period." She had had no ambition, no endurance; she had to drive herself; she was inclined to feel chilly; her appetite was poor and she had lost weight. This was not all because of the disease, since the malignancy was in an unusually early stage, and the symptoms referable to it when she came had been of short duration.

A convalescence such as this is convincing evidence of the effectiveness of the use of thyroid extract in the postoperative management of certain surgical cases. Thyroid administration, when indicated, can then be started to advantage almost directly after the operative procedure. It would seem that in elective surgery it might be used to advantage, in given cases, to prepare a patient for the ordeal of the operation.

No one questions the profound influence of each of the glands of internal secretion and their inter-related action on the body functions, and of these, the thyroid gland has been regarded by the author, for a long time, as the master clock of the endocrine system. Its most important function is, perhaps, the generation of the metabolic activity of the body. In other words, the thyroid is in direct charge, as it were, of governing the chemical changes going on continually in living cells, by which the energy is provided for the vital processes and activities. It acts as a continuous charging mechanism. It controls, normalizes, and stimulates the functional processes of all tissues. In fact it is admitted

to be the activator of all the body cells—that is, when it functions normally.

At the very beginning of life each organism is charged with an energy potentiality sufficient to carry it along for a definitely limited period of time. There is no doubt a considerable variation in the amount of this energy charge in different normal individuals, and the level of this potential force is subject to fluctuation, being elevated, perhaps, through stimulation, or lowered through the influence of extrinsic conditions such as starvation, disease, trauma (operations), and so on. No doubt all of the cells and organs are affected by such conditions, but it seems logical that the cells which are highly specialized in their work, as are those of the thyroid, would be affected to a greater extent and thus exhibit either greater stimulation or a reduced function in a correspondingly greater degree. It is well known, for instance, that operations upon any part of the body in the presence of a smouldering thyroid activity may cause an exacerbation of hyperthyroidism in a way and in a degree quite similar to that following operations upon the thyroid itself. Such a reaction following directly the treatment of tonsil tags with diathermy has just been brought to the attention of the writer. Reactions from stimulation such as this do not follow surgery in which the thyroid is normal in its working balance, and surely not if it is subnormal in its action. Quite the contrary, major operations seem to be followed as a rule by a running down of the machinery rather than by an acceleration of it. Whether this running down of the machinery is the result of damage done to the charging mechanism of the body, which seems to be directly under the influence of the thyroid gland, or whether the discharging mechanism under the influence of the adrenals has been speeded up one cannot say with a settled judgment or conviction, but the former is more likely the case.

The following brief case report is one that is thought to illustrate this point:

A middle-aged man of robust type of constitution was operated a year ago for biliary tract infection. This disturbance dated back four months, as far as could be determined. At any rate, prior to his illness he had been in perfect health. His endurance seemed to be without limit and he never tired. The four months' illness reduced his vitality to a certain extent. His ambition was below normal and he did get tired. Then came his operation, which consisted of a cholecystectomy and an exploration of the common duct. The result of the operation was very successful insofar as it cleared up all of the trouble caused directly by his cholangitis, and more than that it has, up to this time at least, cured him of violent sick headaches which he had had since his early childhood days. The usual postoperative management was carried out, and all was well with the patient except that he continued to lack ambition and had very little endurance. A year from the time of his operation he could not work over two hours a day. What seemed to have happened was this: As a result of his four months' illness prior to his operation, the patient's vitality had been lowered from the high position it had always occupied. Superimposed upon this was the operation which was then the means of the machinery's running down still more. There seemed to be a lack of energy charge to bring his ambition and endurance back to normal, even though the pathological condition which had caused his illness had been removed. Sufficient thyroid secretion was evidently the energy charge that was lacking. Thyroid medication was started a month ago and his run-down feeling has already been boosted to a point where he feels quite like himself again. The improvement in this case is most striking.

The degree of hypothyroidism under consideration is, of course, not that of cretinism or myxedema, but what is meant is thyroid secretion that is less than normal. While the surgeon has interested himself very much in the question of *hyperthyroidism*, and has in fact become very keen in the recognition of the early symptoms and signs of it, he has *not* as yet become interested in the so-called masked or occult type of hypothyroidism. He has left the subject to the internist to worry about, not realizing for the moment that

the surgeon is also a physician, that he does after all practice medicine from the time he first sees a patient until he dismisses him. As a matter of fact, a good percentage of patients that consult him are purely medical cases. If he does not manage them therapeutically he has at least served the purpose of a medical referee. He is frequently called as a consultant. He must on those occasions, at least, be a physician as well as a surgeon. When all is said and done, a well-trained competent surgeon is not content to be a skillful technical machine. Manual dexterity is, to be sure, indispensable to the surgeon. Nevertheless, medicine and surgery and surgical judgment are not functions of the hands.

It is not within the scope of this paper to discuss the entire subject of hypothyroidism, but for all practical purposes the complaint of being tired, of having to drive one's self to his tasks, of lack of "pep," seemingly a favorite expression of a patient so afflicted, may well serve as a hint to suspect underfunctioning of the thyroid, assuming, of course, that constitutional diseases that may cause such complaints have been ruled out. Moreover, patients with this condition have far too often been placed in the neurasthenic group. As a rule those who have a reduced thyroid function have more or less cold intolerance, the skin is inclined to be dry, the appetite may not be up to normal, there may be indefinite joint pains, constipation and headache are common. The history of lack of energy is to be supplemented, of course, with a physical examination, and in some cases the metabolic rate determination may be helpful. In the experience of the writer, if no signs of hyperthyroidism can be elicited (and of these the one he relies upon most is the intensity of the heart action, cardiac overaction being the most dependable and most constant sign in hyperthyroidism) it is safe and good practice, if the history is suggestive of an underfunctioning thyroid, to start thyroid feedings under careful checking and observation. For each individual there is a maximum dose which must be found by experiment. The use of desiccated thyroid extract seems to be very effective and practical. The dosage will depend largely upon the degree of deficiency. The metabolic rate estimation will give a rather definite indication of the amount that is needed, yet without it the dosage can be determined from all the clinical data in hand, with enough accuracy for all practical purposes. Experience has demonstrated that in most cases it is well to use 3, 4 or even 5 grains daily for two weeks and then to reduce the dosage gradually. In any case the medication must be carefully supervised. It has been learned that in some instances two or three months' treatment seems to arouse the thyroid to action so that further administration is not needed. In the majority of cases, however, it has to be given for a number of months, and in some instances it may need to be given indefinitely.

If the condition of hypothyroidism were a rare one, the failure to recognize it would not matter so much. The fact is it is a common affliction, especially here in the Great Lakes District where goiter is endemic, due perhaps to the low content of iodine in the water and soil. In the experience of the writer there is more mild hypothyroidism than there is so-called occult masked hyperthyroidism. The frequency of mild cases makes it incumbent on the surgeon to have the condition in mind.

In the final answer then to "How long will it be after I am operated on before I am as well as I am going to be?" the author wishes to offer the added consideration of the status of the thyroid function in making this appraisal. With a lessened function a retarded convalescence rate can be anticipated. A very slow convalescence rate may be the trial test and therefore the hint that thyroid medication is needed to supply the energy charge that is lacking. This energy charge will not alone be the means of accelerating the convalescence following surgery, but without it the patient's highest health level will never be attained.

DEOXYGENATION AND PUS INFECTION*

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AN abscess cavity is a hydraulic trap. The mechanics of abscess have never been adequately described. We have overlooked the fact that a comparatively high hydraulic pressure is present in an abscess cavity and that it plays a very important part in its development and progress.

That the cavity of an acute abscess carries a high hydraulic pressure is evident when by tactile sense we compare the tension in a boil; or when a blow accidently strikes that angry boil; or when we open a post-tonsillar abscess; or when we observe the spurt of pus from opening a "bursting" abscess; or—ask the patient about relief after opening a dancing felon.

If we keep in mind this hydraulic pressure in the abscess cavity, the mechanics of abscess is fairly simple as the other factors have been well covered by clinical experience and research.

I know of no actual measurement of the degree of pressure prevailing in abscess. Until we develop apparatus to make such measurements, it is illuminating to study comparable measurements which have been made in other parts of the body. Pressure developing automatically in strangulated intestinal loops has been extensively studied by G. E. Burget,[1] J. J. Morton,[2] and several others. Urologists constantly measure the pressures in the urinary bladder and, for further comparison, I had nurses in the Riverside Community Hospital measure the pressure developed in the rectum in expelling enemas. These records give us the following figures and I think we are justified in concluding that the hydraulic pressure developing in abscess, in acute appendicitis, and in strangulated bowel approximates these figures.

Hydraulic Pressure in	Cm. Water
Loop of strangulated intestine	30–55
Urinary bladder	0–50
Intrarectal pressure	20–56

It is interesting to note that Ellis and Weiss[3] found the pressure in arterioles varying from 40 to 65 mm. Hg with an average of 55 mm. Hg. This is 74.25 cm. water and probably registers approximately the limit to which pressure in a pocket in the body will reach.

We have then in the mechanics of abscess these approximate hydraulic pressures to deal with:

	Cm. Water
Arterioles (supplying the part)	80
Veins	0–5
Capillaries	5–10
Possibly capable under pressure of reaching	20
Intra-abscess	20–60

With practically no resistance in their walls, the veins and capillaries operating at 0–20 cm. will be closed by the pressure in the abscess cavity ranging from 20–50 cm.

At the same time the artery at 100 cm. and upward pressure is constantly crowding more fluid into the cavity, closing more veins and capillaries. All body tissues being permeable, fluid will filter in (being propelled by the pressure in the artery) and increase this blockade until a hydraulic balance is established.

The results of arrest of circulation are the same here as in any other part of the

* Read before the General Surgery Section of the Californiaical Med Association, 62nd Annual Session, Del Monte, April 24–27, 1933.

body from any form of pressure. They are the same as those following a band around a limb, a tight bandage or a string around a finger. The first effect is a blueness of the part beyond the obstruction: deoxygenation. This is quickly accompanied by swelling: effusion. That these same effects are present following this internal pressure is very evident from the congestion, blueness, the swelling and the throbbing pain which accompanies abscess.

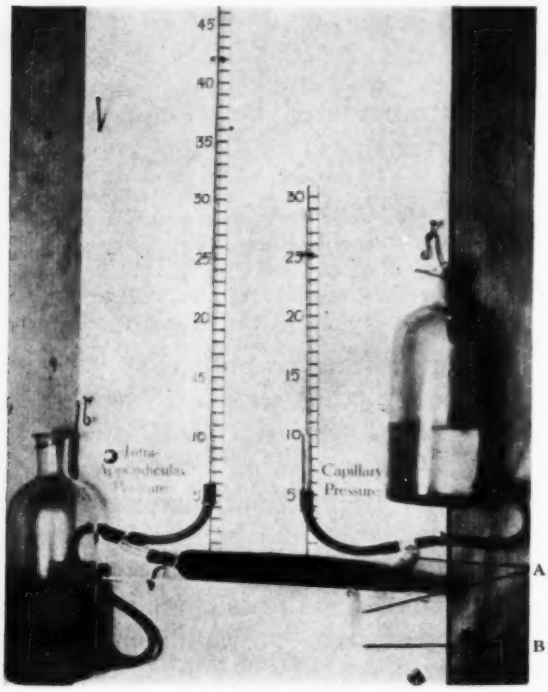

Fig. 1. A, Tube (capillary) running between two layers (wall) to tip and back. B. Free flow of circulation. Normal capillary pressure 10 cm. water.

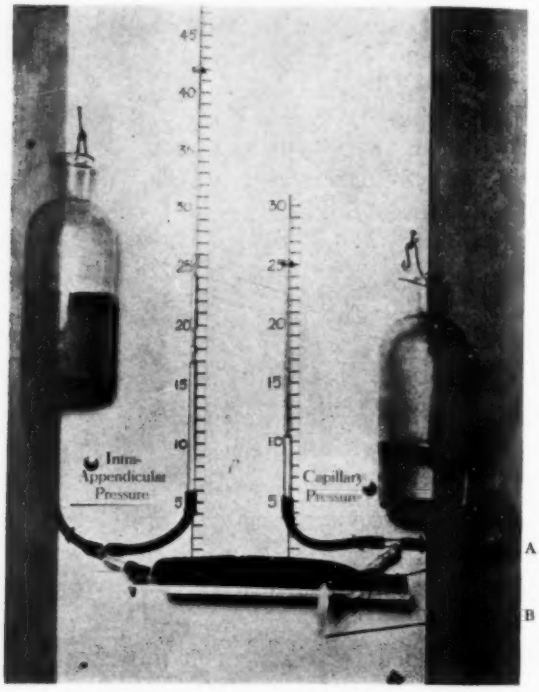

Fig. 2. A, Obstruction (marble) in constriction. Flow arrested. Effusion into lumen arrests capillary circulation at 20–25 cm. water.

The reason for this effusion, the increased permeability of the capillaries in the face of obstruction and from the loss of oxygen, the resulting chemical changes in the blood and tissues, and their effects upon osmosis have been thoroughly studied by physiologists (see Krogh[4]).

This in brief is the hydraulic trap.

The arteries force fluid in, while the capillaries and veins cannot carry it away because they are closed by the intra-cavity pressure. The more pressure the more effusion, more pressure, more blockage, more effusion, more pressure, more blockade, *a hydraulic trap*, the result of a *hydraulic vicious circle*.

As the pressure in the cavity increases, the damming back of the circulation involves the arterioles and causes complete arrest of the circulation in that area.

The amount of tissue involved depends upon the extension of the cavity, the severity of the infection, the virulence of the bacteria, the relative immunity of the tissues and many other factors. The arrest of circulation covers such areas as may be necessary to balance the hydraulic pressure in the cavity with the propulsive force of the arteries supplying the tissues.

The fact that *deoxygenation* to the point of strangulation is a result of this internal pressure is also constantly overlooked and my purpose in this paper is to call attention to this fact. It is a condition which has not been discussed in medical literature. The only reference to it so far as I know appears in "Hydraulic Vicious Circle as it Develops in Appendicitis."[5]

We know that blueness (deoxygenation)

follows arrest of circulation by a string around a finger, and the same deoxygenation follows arrest of circulation from internal hydraulic pressure. By actual oxygen determinations both G. E. Burget[6] and Morris Visscher[6] demonstrated that this same deoxygenation from the same mechanics is present in a strangulated knuckle of the intestine. All of us appreciate the disastrous effect of the disappearance of oxygen following arrest of circulation. No part of the body can live without oxygen, but in abscess this death from lack of oxygen is precipitated by the presence of bacteria which prefer to grow in an *oxygen-free* medium. Practically all pus-producing organisms are at least facultatively anaerobic and the absence of oxygen gives them the opportunity to grow and to develop their infective process. A perfect anaerobic culture tube is formed.

This is the all important step in abscess formation: arrest of circulation, disappearance of oxygen, the growth of bacteria, the formation of toxines, death (necrosis and gangrene of tissues), a gradual spread of the abscess in the direction of least resistance and then rupture through the necrotic tissues.

Of late we have been more and more impressed with the fact that bacteria enter the circulation quite freely. Is it fair to assume that these bacteria are harmless in the presence of free oxygen supplied by an unimpeded circulation? But allow a number of these bacteria to accumulate behind any foreign substance or in any blind end of capillary sufficient to allow a small area of tissue to be deprived of oxygen and a culture tube will be formed, and these bacteria will grow.

When the circulation is arrested as a result of injury and especially in the presence of a foreign body, a hydraulic vicious circle with deoxygenation will develop.

Per contra, remove the pressure from the capillaries and veins by rupture or artificial opening of the abscess, and allow a return of the circulation with life-giving oxygen and the bacteria quickly cease to grow, and recovery from the infection is prompt. The all-important result of breaking the hydraulic vicious circle is the return of oxygen. Granulations (new capillaries) are the next step. Nature's process of repair, and how many hydraulic factors control here.

Fig. 3. Skiagraph. Air distention held by ball valve.

These granulating tissues with the abundance of oxygen are a perfect shield to the penetration of bacteria into the tissues. The absorption of toxins and the penetration of bacteria require a superimposing pressure to drive them into the tissues. As long as perfect drainage allows the perfect functioning of these capillaries, there will be no extension of infection and no absorption of toxins.

FORMATION OF NEW CAPILLARIES

In the process of repair new capillaries must be provided. This hydraulic study suggests a simple and automatic method. The mass of cells in the area of repair are irregularly placed like grains of sand in a hill. Microscopic trickles of fluid pass through them from the arterial circulation to the venous, like the rivulets in the sand on a hillside in the rain. Water always runs

down hill in the body as well as in the sand, or in other words "in the direction of least resistance," always from the artery towards the vein. This trickle through the mass of cells becomes a microscopic rivulet and eventually an established stream. Automatically it finds its location where it is most needed. Finally the cells on all sides "stick" and form a wall; a new capillary with a capillary wall has been formed. This capillary needs only to dilate to make an arteriole or a vein or any blood vessel which may be needed to supply the part adequately. The new capillary carries abundant oxygen and the anaerobic bacterium cannot live. It is thrown off as a part of the pus and débris.

As a demonstration of what relief of the circulation will do as well as a therapeutic measure, I have treated several abscesses by aspirating the pus and replacing it with a smaller amount of air, so little that there could be no pressure remaining in the pocket. All I did was to take the pressure off the capillaries in the walls of the abscess and thus allow oxygen to reach the tissues. This was suggested by Dana's[7] method of treating empyemas by replacing the pus in the pleural cavity with air.

The following illustrates its clinical application in a young man of fifteen.

For several days the patient had fussed with and had squeezed an acne furuncle until, when he came to me, he had a soft bulging abscess on his neck under the jaw, 1½ inch in diameter. The overlying skin was blue, congested and cyanotic without a definite threat of opening anywhere. I aspirated 6 to 7 c.c. of pus with a large needle and replaced it with 3 c.c. of air. Two days later I withdrew 3 or 4 c.c. of pus which was watery and very bloody and replaced it with 2 c.c. of air, leaving together with that previously introduced, 3 or 4 c.c. of air. Two days later aspiration withdrew 2 c.c. very fluid contents containing considerable bright blood. The tumefaction was now one-half smaller and soft with the feel of air moving about easily in the cavity. No air was added this time. The skin had now resumed practically a normal hue, being only slightly dusky. Pain and discomfort were absent from the first treatment and no dressings of any kind were used. By the end of one week he was practically well.

It was interesting to see the rather prompt return of normal circulation in the skin as the internal pressure in the pocket was removed. It demonstrated beautifully that the dusky, cyanotic hue was due to pressure *inside* the abscess.

I am not advocating this as a routine treatment of abscess, for incision is very satisfactory, but the fact that there is less pain from a needle than from a scalpel, that no dressings are needed, and that there is no scar afterward will recommend it in many cases.

It is, however, a demonstration of the effect of relief of blood stasis by removal of hydraulic pressure, of the benefits of a return of oxygen and of a consequent overpowering of the infection. The aspiration relieves the pressure upon the veins and capillaries in the walls of the abscess, insuring a return of oxygen to the tissues. Oxygen is all that is needed. The cushion of air is absorbed slowly, meanwhile preventing return of pressure but allowing the reaccumulated pus to gravitate harmlessly to the bottom of the pocket. The amount of air is regulated to prevent *pressure* in the abscess *above* 10 *cm. water*, and thus insure free flow in the capillaries with their necessary functions. Reaspiration has not been necessary oftener than every two to five days. The results have been very satisfactory.

I should like to see this method tried on joint infections, pericarditis, deep-seated abscesses hard to open on the surface, possibly in the abdomen, perhaps in the brain or spinal cord.

It is interesting to note the use of air in gonorrheal arthritis of the knee joint by Porter and Rucker[8] and by Hedrick. Does not this study of hydraulic pressure explain some of the reasons for the success of their procedure? The effusion into the joint under pressure is the prominent point

in the pathology and, although often not a distinctly purulent process with definite pus-producing organisms as the principal factor, the relief of this pressure from the capillaries in the synovial membrane has an effect similar to the condition in abscess. Abundance of oxygen and perfectly functioning capillaries are Nature's best defense and providing free circulation where previously there was pressure from accumulated effusion must be helpful.

With this in mind I believe Hedrick's plan to measure accurately the amount of pressure left in the knee to be very important. The amount of pressure should not be over 15 or at most 20 cm. water. At that pressure there may be slight interference with capillary circulation in the synovial membrane for a short time but the excess of air is quickly absorbed, and the pressure lowered. At 15 to 20 cm. a repetition of aspiration with replacement of air may be needed at shorter intervals, but the ideal pressure would be more nearly reached.

The pressure used by Hedrick (30 to 40 hg) did well, but no doubt a slight excess of pressure was quickly absorbed and the same result obtained. It will be interesting to learn by experience just what pressure will give the optimum of relief and the best final result.

This same relief of pressure from capillaries would seem to explain the brilliant results reported by Dana[7] in his treatment of empyema by replacement with air. The capillaries and veins in the pleura are relieved of pressure. For the same reason, a manometer such as is used in pneumothorax in tuberculosis would seem to be a valuable addition to the apparatus used in this procedure.

Evidently the normal treatment of abscess is drainage. This has always been Nature's way and we imitate her by opening abscesses freely.

Adequate drainage has long been insisted upon by good surgery, but this deoxygenation principle offers a new and adequate reason for it, and an explanation of its mechanics, and an indication for varying technique in unusual conditions.

The capillary is the all-important organ in the mechanics of repair. Given a normal capillary with full complement of oxygen, and pus bacteria are harmless. In the presence of such normally functioning capillaries they cannot become established and will be quickly eradicated from infected tissues. But it can have no interference with its function. Its blood supply must be allowed to flow freely. Any pressure upon it of 10 cm. and upwards will interfere with its function and produce disastrous deoxygenation. Drainage must be so free that hydraulic tension in the tract will always be as near zero as possible.

In establishing drainage of any kind in the body, whether it be abscess of urinary bladder or uterus or intestine, this demand to keep pressure off the capillaries will often determine the proper method to be used in any given condition. Always the drainage tubes or the rubber tissue or the absorbing gauze must be so placed that there is no opportunity for blockade with resulting back-pressure closing the capillaries. We all know how disastrous to the skin is the continuous pressure of a cast or retaining apparatus. Why have we not appreciated that *hydraulic* pressure in a pocket has the same effect as a hard solid body?

What a comfort to know that re-dressing a wound which has been covered by granulations or protecting crusts or the coagulated serum of a simple incision carefully approximated is practically proof against infection from the outside. So long as no bacteria are placed inside the wound or driven into the tissue by pressure there will be no infection.

The metriculous care often imposed on those re-dressings calling for sterilization practically equal to that of the original operation is, in the light of these studies, wasted energy and material. Bacteria must be placed *inside* the tissues and by the presence of foreign bodies, débris or blood clot; the capillary stream must be arrested

and deoxygenation established before infection can take place.

The idea of a hydraulic vicious circle grew out of a study of the cause of appendicitis.[5,9] It was demonstrated on the intestine in 1907.[10]

Abscess, appendicitis, knuckle of bowel, diverticulitis, all closed pockets develop a hydraulic vicious circle, and make a perfect anaerobic culture tube. All the conditions necessary for the growth of bacteria are present and anaerobes, if present, develop promptly on account of oxygen being excluded.

ABSCESS OF LUNG

Applying this principle of hydraulic vicious circle to abscess of the lung presents some special problems. The etiology of abscess of the lung has been the subject of much study. It has long been evident that the presence of bacteria in the lung is not sufficient to produce abscess. The epithelium lining the air spaces is very resistant to bacteria and simple pneumonia hardly penetrates it.

The lungs harbor large numbers and a wide variety of bacteria and yet abscess rarely develops. Pneumonic processes of many forms are accompanied by comparatively few abscesses. Much time and energy have been spent on the effort to discover some specific germ which might be the cause. Many different bacteria are found, but none have been found specific for abscess. Aside from the resistance of the lining epithelium to the penetration of bacteria, the hydraulic vicious circle offers the following plausible explanation. The mechanics of the lesser circulation make it very difficult to produce a hydraulic vicious circle in the lung. The circulation in the pulmonary artery and vein is a very short back and forth shuttle, in comparatively large blood vessels including capillaries, and the hydraulic pressure in them is consequently *very low*. Blood pressure in them hardly exceeds 15 cm. to possibly 20 cm. water. The pressure in the return stream in the wide pulmonary veins assisted by the suction of the powerful left heart is very low: 0 to 5 cm. That in the pulmonary artery is only a little more.

A pocket filled from effusion from the pulmonary artery could therefore hardly reach a point where it would arrest the return flow through the pulmonary veins. It seems therefore necessary to call upon the *bronchial artery* to supply the necessary pressure to produce a hydraulic vicious circle in the lung. There is no other source of supply with sufficiently high pressure to close the capillaries and veins and thus deprive the tissues of their life-preserving oxygen.

The bronchial artery has a comparatively sparse complement of branches and connecting capillaries and it is probable that a considerable accumulation of débris and infiltration is necessary before the back pressure can reach the branches of the bronchial arteries. Either the initial implantation must be very near a bronchial artery or the atelectasis or the pneumonic infiltration must be sufficiently extensive or concentrated to reach it. There must be sufficient accumulation to affect the bronchial circulation, and the vicious circle must be built up from the higher pressure in the bronchial artery.

This will explain the rarity of abscess accompanying foreign bodies in the bronchi. Chevalier Jackson,[11] commenting upon this fact, reports many remaining for months, even years, yet no abscesses were found in over 1500 cases. The foreign body produces ulceration but not sufficient infiltration to arrest the bronchial circulation enough to produce a vicious circle. Bacteria aplenty are present in the lung, but a mechanical step is necessary to produce abscess. Hydraulic vicious circle and the bronchial artery supply this missing link.

CONCLUSIONS

1. Deoxygenation is an important factor in infection with pus-producing bacteria, probably an essential step.

2. Pus-producing bacteria are in the main facultatively anaerobic.

3. They are always present in the alimentary canal, increasing in numbers in the lower intestine, especially in the colon and appendix.

4. Many bacteria commonly float in the blood stream and cause trouble only when some obstruction holds them to make the nidus of a hydraulic vicious circle.

5. Stasis is the result of hydraulic pressure in a pocket or closed cavity.

6. Deoxygenation follows stasis of the blood stream.

7. The result of the stasis and its accompanying effusion is a hydraulic vicious circle.

8. Drainage, allowing return of circulation with oxygen, arrests the further growth of anaerobic bacteria.

9. Drainage must be so complete that back pressure cannot reach the average capillary 10 cm. and the nearer zero it can be kept the better.

10. A properly functioning capillary is perfect protection against pus producing bacteria.

11. The lung is protected against abscess formation because of the difficulty of establishing a hydraulic vicious circle.

12. Probably infiltration or accumulation of débris must involve branches of the bronchial artery before the back pressure will be sufficient to produce hydraulic vicious circle.

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* Continued from p. 335.

POSTPARTUM AND PUERPERAL CARE

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WHILE the conduct of labor usually is regarded of greatest importance in the management of an obstetrical case, the morbidity and mortality that may result from inattention during pregnancy or the puerperium make fallacious a distinction between the relative value of prenatal, natal, and postnatal care. The period after delivery offers many attractive possibilities for successful treatment, and deserves more serious consideration than it is frequently given. Much can be done for the immediate safety and comfort as well as the remote well-being of the puerpera. Careful attention to her needs will be rewarded with gratifying results. In the following paragraphs a statement is made of the procedures that have served the author well in this important division of obstetrical practice.

For practical purposes the postpartum period may be thought of as comprising the twenty-four hours following the birth of the child, although, strictly speaking, it does not begin until after the expulsion of the placenta. As the child's body is being born, 1 c.c. of solution of pituitary, U.S.P. x (10 international units), is given hypodermically to hasten placental separation and diminish blood loss[1] during the third stage. The perineal wound, if there is one, is packed with gauze to retard oozing while attention is being given to the child. The uterus is palpated gently at intervals to make certain it is not being ballooned out with blood, and, in the absence of hemorrhage, is let alone, since stimulation by massage or premature attempts at expression[2] may initiate abnormal contractions and interfere with the separation and expulsion of the after-birth. The umbilical cord is not divided until its pulsation has ceased. By the time the child has been attended to the placenta has become detached in the large majority of cases and is ready for expression. There is good evidence to show that its further retention tends to increase the amount of blood[3] lost in the third stage. As soon, therefore, as the signs of separation appear, the fundus is grasped in the left hand with the fingers behind and the thumb in front, and brought to the midline of the abdomen. When firmly contracted it is used as a piston to force the placenta from the lower uterine segment or vaginal vault. The placenta is supported with the hand as it emerges from the vulva to prevent its dropping into the basin with possible tearing of the membranes by sudden traction. Adherent membranes are removed by grasping the lower segment above the pubis between the thumb and fingers of the right hand and making pressure upward, thus raising the uterus out of the pelvis. The counter-traction made by the weight of the placenta usually detaches the membranes slowly and completely. If they begin to tear, they are grasped near the vulva with an artery forceps and slowly withdrawn. An active preparation of ergot[4] is then administered to supplement with its slower and more prolonged action[5,6] the transitory effect of the pituitary solution. The secundines are examined carefully as soon as expelled so that a missing cotyledon or succenturiate lobe may be recovered while conditions still are favorable for invasion of the uterus. Every effort is made to limit the loss of blood to the smallest possible amount.

If separation of the placenta is delayed for more than two hours or if bleeding becomes alarming, failure to effect separation and expression by Credé's technique is followed by manual removal. Precautions

are taken against the introduction of infection by sponging the vulva with an antiseptic, redraping the patient, and changing the gown and gloves. The elbow length glove is a great aid to the satisfactory performance of this operation.

Atonic bleeding usually can be controlled by compression of the lower uterine segment against the sacral promontory and massage of the fundus[7,8] with the opposite hand, supplemented with injection of additional pituitary solution. This maneuver eliminates contamination of the cervix which may occur when it is forced down[9] to the vulva. Should bleeding continue, the manual removal of clots or retained placental fragments and bimanual massage with one hand in the uterine cavity and the other on the lower abdomen almost always will be effective. The intrauterine douche of hot saline solution is also an efficient hemostatic. Tamponade of the uterus is only rarely necessary, and, when done, the packing is removed after six or eight hours to minimize the danger of infection.

Bleeding coming from a torn cervix is controlled by suture after the placenta has been expelled. Hemorrhage from that source is rarely encountered since it almost always follows injudicious attempts at delivery through an incompletely dilated os. It is a matter of experience that important cervical laceration occurs only with extreme rarity when the first stage of labor is allowed to complete itself naturally, and it follows that routine examination of the cervix is superfluous if not dangerous.

After the uterus has become well contracted and retracted and bleeding has ceased, any open perineal injury is repaired. Except in very shallow lacerations or incisions, repair is much facilitated by placing the patient's feet in stirrups and bringing her hips to the edge of the table. Accurate anatomic approximation of divided tissues with a minimum of catgut and without undue tension then becomes relatively easy, and is followed almost uniformly by primary healing. The perineal skin is brought together with either interrupted silkworm-gut sutures or a continuous subcuticular stitch of the same material. In potentially infected cases healing is favored by the use of figure-of-eight silkworm-gut sutures which eliminate the necessity of buried catgut in the perineum. When there is gross infection, primary repair of perineal wounds is not done. The operative field may be kept bloodless by placing a taped gauze sponge in the vagina. The tape, with a hemostat attached and lying on the lower abdomen, practically obviates the danger of forgetting to remove the gauze at the close of the operation.

The patient is watched carefully for atonic hemorrhage for one hour after the delivery of the placenta. The importance of this rule cannot be overemphasized. Before she is left the condition of the uterus is observed, and any clots present in the genital tract are expressed. An ice-bag is kept applied over the fundus for twenty-four hours, and a course of ergot consisting of one dram of the fluid extract given every four hours for six doses is administered. Except in the presence of extensive lacerations or other conditions that make movement painful or dangerous, the patient is encouraged to move about freely in bed from the start. The back rest is allowed[8,10] for meals and at other times as desired. Lying on one or the other side and turning upon the abdomen several times daily are advised. By these measures firm retraction of the uterus and drainage are favored, and the danger of infection from upward migration of vaginal bacteria is lessened.

Free ventilation, and sunlight when possible, are provided. Temperature and pulse rate are recorded at least three times daily, and a careful watch is kept for infection or intercurrent disease. In women who have had pregnancy toxemia, frequent blood pressure determinations and close observation of symptoms will reveal the course of the condition and indicate treatment that may avert a serious convulsive state. When it is remembered that post-

partum eclampsia may occur with little evidence of toxemia before or during labor, the necessity of keeping alert for this possibility during the early puerperium is evident.

Adequate rest and freedom from pain are important factors in recovery from the ordeal of parturition. Pain in the puerperium, whether from uterine cramps, wound, or breasts, is usually a matter of only the first three or four days, and, if it is not relieved by the well-known combination of aspirin, phenacetin, and codeine, or by some other synthetic analgesic, morphine is given freely. The early administration of ergot in a measure prevents after-pains by keeping the uterus in a state of tonic contraction. The mother is allowed to get unbroken rest at night by administration of a sedative, if indicated, and by elimination of the 2:00 A.M. nursing until lactation is well established. In many cases, especially when the mother is frail, this feeding can be omitted entirely since most infants of average weight develop and gain normally[11] with five feedings in twenty-four hours.

Unless there is some definite reason for limiting the diet, such as toxemia or digestive disturbance, food in the amount and variety dictated by the appetite[12,13] is given from the beginning, with supplementary nourishment between meals. Simple nutritious food, with an abundance of fresh vegetables, fruit, and milk,[14] is a physiological necessity to overcome the varying degree of exhaustion resulting from labor and to establish satisfactory lactation.

Perineal care given is reduced to that necessary for cleanliness, comfort, and the prevention of contamination from without. Before the patient leaves the delivery table the pudendal region is bathed with sterile water or a mildly antiseptic solution, and a sterile vulval pad is applied. This is changed as frequently as it becomes soiled. Since the pads can carry as well as prevent infection, the nurse is instructed to take care in changing them to avoid contamination of the vulva from the region of the rectum. Early in the puerperium the parts are washed once or twice daily with sterile warm water and soap, with care to avoid the stitches and interference with healing. Pitcher irrigations as ordinarily given do not cleanse, and are used, if at all, only for the patient's comfort following urination. After movement of the bowels the soiled skin is cleansed with pledgets of cotton wet with bichloride solution. After healing of the perineal wound and the removal of sutures, usually by the eighth day, these special measures are discontinued, and the ordinary attention for a bed patient is given. Experience shows that the healing of perineal wounds has little relation to the type of perineal care observed. They are sealed within a few hours,[8] and it seems more reasonable to attribute defective healing to some error in the technique of repair or to the introduction of infectious material during the operation.

Catheterization is done without hesitation if the bladder becomes distended during the first twelve hours and if spontaneous urination does not occur in spite of the employment of the usual measures that encourage it, including the assumption of the sitting posture. The cases of reflex retention that require repeated catheterization are few. In these it is so timed as to prevent the accumulation of more than 10 ounces of urine in the bladder. Careful aseptic technique is observed, and methenamine and sodium acid phosphate are administered. It is true that a certain degree of bladder injury occurs[15] during parturition, but when further preparation[16] of the soil for infection by over-distention is avoided, cystitis resulting from the use of the catheter becomes practically nonexistent. If it is necessary to empty the bladder artificially in women who have had residual urine from cystocele of long standing and who are, therefore, more susceptible to infection, cystitis is most effectively prevented by "continuance[16] of catheterization until the general tone of

the bladder, and perhaps of the patient, has returned to normal."

On the morning of the third day, unless spontaneous movement of the bowels has occurred, the colon is evacuated, usually with a suds or soda enema. By this time the puerperal wounds have had an opportunity to establish natural barriers to infection, and the danger of contamination from the rectum is not so great. One of the saline cathartics is given when there is unusually painful engorgement of the breasts, and, if the patient objects to enemas, milk of magnesia or one of the mild laxatives acting on the lower bowel is used. The constipation that follows delivery is of the rectal type, and, since it can be so effectively relieved by these simple undisturbing means, there seems to be no justification for the routine administration of castor oil[17] or other purgatives which disturb the gradient[18] and upset physiological processes throughout the intestinal canal before they reach their desired point of action.

Sometime within the first twelve hours, depending on the mother's condition, the breasts and nipples are washed with soap and water, and nursing is begun. The baby is put to breast every four hours, with usual omission of the 2:00 A.M. nursing during the first four or five days, and, in some cases, entirely. If there is evidence of hunger at this time, a supplemental formula feeding[19] provides for the infant's needs, and prevents disturbance of the mother's rest. Exposure to the air seems to reduce the incidence of tender, fissured nipples. Ordinary cleanliness of the breasts, as secured with soap and water, is maintained. The application of boric acid solution to the nipples before and after nursing is not favored by theory or clinical experience, and is regarded as a needless refinement. Engorged, pendulous breasts which from their weight are a source of discomfort, are supported for a few days with a binder. Depletion is hastened frequently by applying ice-bags or hot boiled water compresses, limiting the fluid intake, and administering a saline purge. Pain not controlled by these means is relieved by an anodyne. Fissures of the nipple usually heal rapidly with rest as secured by the use of the nipple shield or electric breast pump, the application of some soothing, oleaginous substance, and infra-red irradiation. Sterile gauze squares are kept applied until healing is complete. Successful maternal nursing is striven for both to promote the best interests of the child and to favor involution of the genitalia. A cheerful attitude and freedom from worry are encouraged, and an attempt is made to eliminate any factors that may have an unfavorable psychic effect on lactation.

The abdominal binder is not used routinely, but when there is a feeling of emptiness and lack of support, one is kept loosely in place for several days. Abdominal muscle tone, impaired by prolonged stretching, is restored most effectively by active exercises. In addition to encouraging free movement in bed, graduated exercises involving the abdominal muscles in particular are prescribed. Head raising is begun during the first twenty-four hours, and after the third day flexion and extension of the thighs, first alternately and then both together, are carried out. Deep breathing with extension of the arms above the head is good. Raising the body to a sitting posture[11] without the aid of the arms is practiced after the first week. These exercises not only help to restore muscular tone but improve the circulation and hasten the return of strength and a feeling of well-being. It seems that, when begun early in the puerperium, they offer the most logical means of preventing permanent relaxation and weakness of the abdominal walls with resulting visceroptosis, backache, and lower abdominal pain. After the patient is up and about, she is instructed to continue the exercises and to wear a temporary abdominal support until the muscles have regained their strength. If permanent relaxation becomes established, such a support is only a palliative

rather than a curative measure. Sacroiliac relaxation with pain is treated with a properly adjusted belt.

Since one of the principal reasons for keeping the puerpera in a recumbent posture is avoidance of strain upon relaxed and weakened supporting structures by a large heavy uterus, the length of the stay in bed is not made a matter of routine, but is determined by the degree of involution of the genitalia. A period of at least ten days in bed is always observed, with prolongation when necessary until the uterus has receded into the true pelvis. Gradual resumption of activity is enforced. Climbing stairs before the end of the third week is prohibited, principally to impress upon the patient that she is in no condition for strenuous or fatiguing exercise. Usual activity is allowed after six weeks if involution is complete at that time. The need of sufficient rest and sleep is stressed. The responsibilities of motherhood tax many women to the limit of their strength, and account for many of the functional nervous disturbances seen after delivery. Since under ordinary conditions the cervical canal is closed and the endometrium, except at the placental site, is regenerated by the end of the third week,[20] tub baths are then permitted. Coitus is interdicted for six weeks.

Pelvic examination is done routinely on the twelfth to fourteenth day to determine the condition of the pelvic floor and cervix, and the position and degree of involution of the uterus. Although puerperal retroversion often is an apparently innocuous condition, troublesome symptoms at times produced by it[21,22,23] make its prevention worth attempting. Polak[8] and others have observed a definite reduction in its incidence when exercises tending to throw the uterus forward by gravity were performed for from six to eight weeks following delivery. As a rule, unless contraindicated by infection, the assumption twice daily of the knee-chest posture is ordered begun on the seventh[19] day. The average patient feels equal to it then, and involution of the uterus already may be sufficient to make possible its falling back into the hollow of the sacrum. Usually this position is maintained for only a minute or two at first, but, with increasing strength, the period is lengthened to ten minutes. The knee-chest position tends to throw the uterus forward, empties the pelvic veins, improves pelvic circulation, and hastens involution. A similar effect may be secured with the "monkey trot" and[8] "mule kick" after the patient is up and around. Distention of the bladder and overloading of the rectum are avoided since they favor uterine displacement and pelvic congestion. The knee-chest posture is especially indicated if there are persistent bloody lochia, and the fear of embolism is not allowed to interfere with its assumption unless there is something to indicate infection involving the pelvic or femoral veins. The source of emboli in the puerperium is not the placental site but the larger veins[24] in the broad ligaments and lower extremities. Movement is avoided as far as possible if there is a suspicion of thrombophlebitis, but, as a general rule, exercises[25] for preventing venous stasis, thrombosis, and possible embolism are looked upon with favor.

If retroposition of the uterus occurs in spite of the precautions mentioned, nothing is done about it unless there are continued bloody lochia[26] or backache, symptoms due usually to[27] subinvolution. In that event the uterus is reposited manually at the end of the third week, and held in position with a Smith pessary. When done under aseptic precautions this carries no risk of uterine[11] infection. The pessary is left in place until involution is complete, that is, until the sixth or eighth week. Retroversion with symptoms persisting after this is dealt with by operation. Symptoms accompanying "congenital retroversion" and resulting from faulty skeletal poise are attacked by postural and orthopedic[28] management.

For subinvolution the knee-chest posture is prescribed provided its assumption is

not made unsafe by coincident infection. The local circulation is further improved by additional ergot and long hot douches begun after the third week. Such causal conditions as retrodisplacement, retained placental fragment, or diseased endometrium are given appropriate treatment.

Cervicitis and erosion observed at the sixth or eighth week are managed effectively[29–32] by electric cauterization. Leucorrhea from this source is thus cured, and extension of infection hindered. Such care of the cervix is of importance also in the prevention of cancer.

When for some reason further childbearing is inadvisable, the patient is not merely admonished to avoid pregnancy, but she and her husband are instructed in a reliable means of contraception.

Anemia, various effects of toxemia, pyelitis, heart disease, tuberculosis, goiter, and other non-pelvic conditions often require observation and treatment after involution is complete and normal anatomic relations have been restored. Coöperation with experts in other fields of medicine is advisable in their management.

In ideal obstetrics the mother's physical and mental condition is left unimpaired; she is able to meet the increased demands made upon her by the child and at the same time retain good health and the joy of living. The care after delivery outlined in the foregoing paragraphs will aid in the realization of this ideal.

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A NEW SUTURE IN PERINEOPLASTY

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THE more recent principles and mechanisms involved in the successful physiological, functional and cosmetic repair of the perineum has, I believe, been summed up by Sturmdorf in a most satisfactory manner. However there appears to me even in his technique one grossly weak point, which leaves a dangerous and unsurgical possibility for infection, i.e., the separation of the vaginal mucous cone from behind the levator shanks by any oozing or accumulation of fluid in the potential dead space which he, and everyone heretofore, have relied upon an unmechanical, unsatisfactory, freely moveable and constantly shrinking, iodoform pack to hold in place.

The description of the practically universally accepted incision in the vulval mucosa from the lateral limits of the laceration, which had previously been the posterior commissure, to the scar tissue mucocutaneous center of what has become the newly formed posterior commissure by the laceration, will not be dealt with at length in this paper, nor will the triangular flap of mucous membrane of the posterior vaginal wall, which is elevated up to the apex of the rectocele. In the dissection of this flap, it should be necessary to use sharp dissection in the median line only, which conforms to the scar incident to the laceration. As this scar is incised, the lateral dissection down to the levator shanks and up to the apex of the rectocele can be carried on by blunt dissection. If the index finger of the left hand is inserted behind the perineum between the levator shanks, and traction is made downward, it facilitates the delineation of the separated levator muscles and facilitates the dissection of these muscles in large bulk, which is necessary to the proper coaptation of these muscles.

If the operator will be content to apply the first suture approximating the levator muscle shanks to the more accessible portions of the levator muscles, and use this suture for traction, the dissection of the upper limits of the levator toward the pubic arch will be made more readily, and the upper sutures can be placed more accurately and more securely and, at the same time include a larger mass of the levator muscles. The lower sutures approximating the levator muscles can be placed simply also by traction on the middle suture.

A No. 2 chromic suture is next inserted just submucous to the lateral limit of the tear on the patient's left, and including some of the levator fascia, and also taking a superficial bite into the coaptated levator shanks and is passed through the levator fascia on the patient's right just submucous to the right limit of the laceration. The ends of this suture are left loose for the present.

A suture which has one definite purpose and which I have not seen described in any literature is the sole excuse for publishing this paper. At the apex of the triangular mucous flap, which has been elevated from the posterior vaginal wall, is placed a submucous suture of No. 2 chromic catgut from left to right, as illustrated in Figure 1. The right half of this suture, armed with a needle, is carried down behind and a little to the right of the median line of the sutured levator shanks and is brought through the right bundle of levator muscle, about 2 cm. from the median line. The left half of this submucous apical suture is armed with a needle, which is likewise brought down behind the left levator shank, which it pierces and emerges about 2 cm. to the left of the median line; the ends of this suture are allowed to remain loose for the time being. Care must be

taken in applying this suture, that the needles which are brought down behind the levator muscles do not injure the rectocele, which is just beneath them.

Figure 2 illustrates the placing of this suture, and the loose ends emerging from the lateral levator shanks.

The triangular musous-membrane vaginal flap is now converted into a cone by the suturing of the lateral cut edges to one another, leaving the invaginating suture within the cavity of the cone, as illustrated in Figure 3. As the lateral mucous-membrane margins of the cone approach the

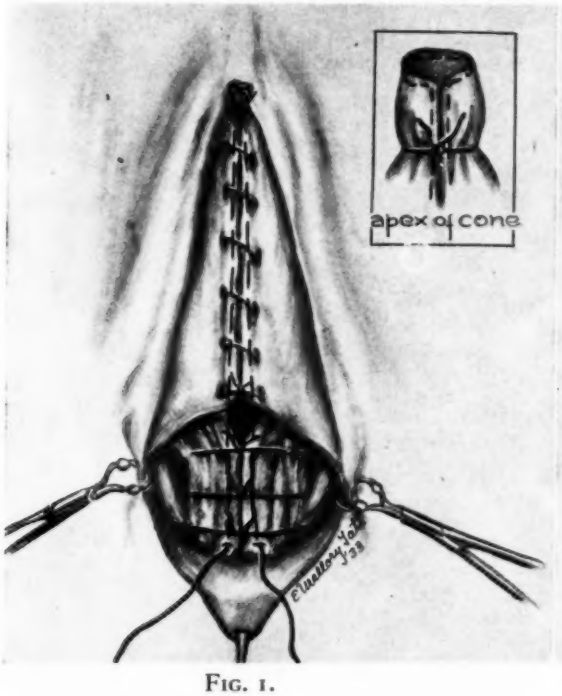

Fig. 1.

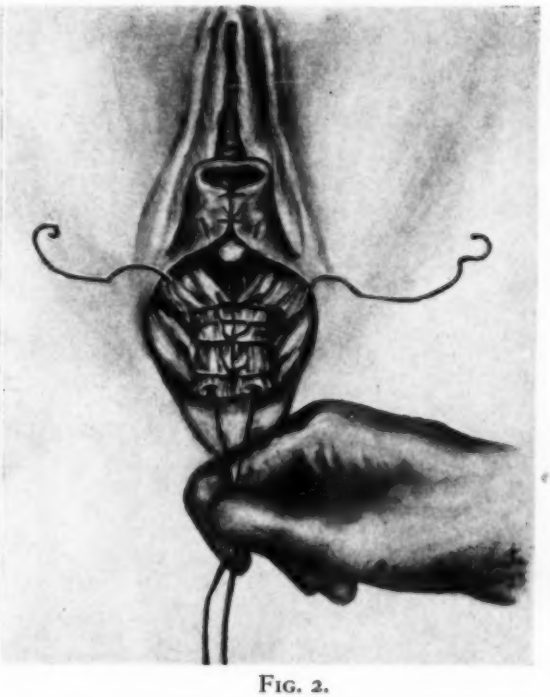

Fig. 2.

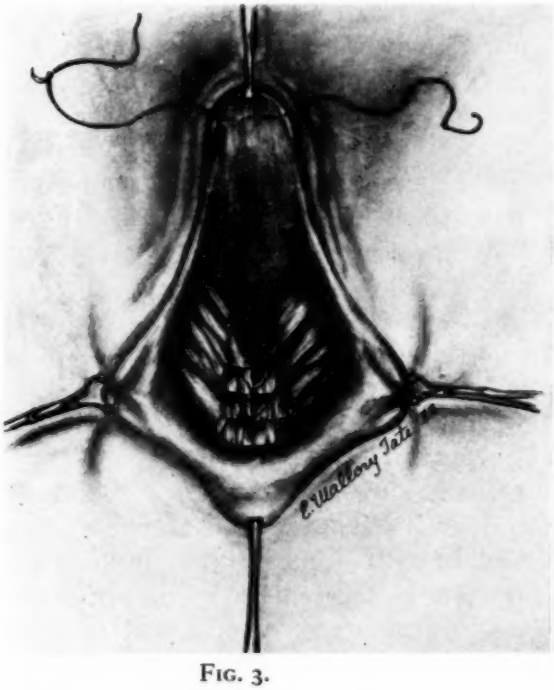

Fig. 3.

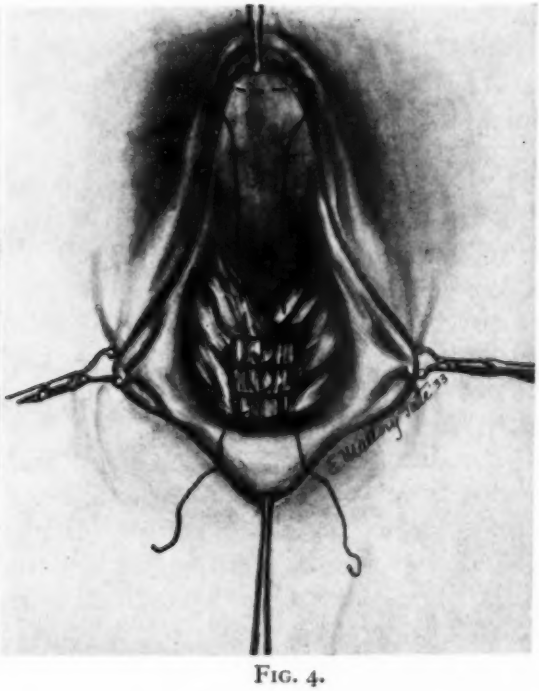

Fig. 4.

new posterior commissure, the afore-mentioned suture, which extends from the lateral margins of the laceration, is tied,

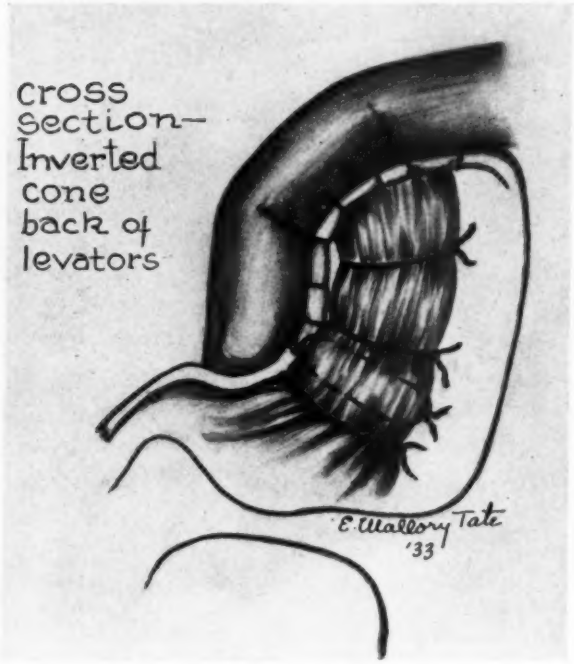

Fig. 5.

which establishes the new posterior commissure in the original position it occupied before the laceration took place. As the suture of the mucous-membrane flap approaches the new posterior commissure, it is tied and cut. This leaves the newly established mucous-membrane cone, which is to cover the posterior vaginal wall, extending up toward the pubis. At this point traction is made on the two loose ends of the suture emerging from the shanks of the coaptated levator muscles, which is secured to the apex of the cone. This invaginates the cone upon itself and secures it firmly and snugly at the apex of the angle formed by the posterior vaginal wall and the back side of the levator muscles. The process of invagination is illustrated in Figure 4.

Figure 5 illustrates the cone-invaginating suture in place, holding the apex of the cone firmly against the posterior side of the levator muscles and effectually obliterating the unsurgical and dangerous dead space in a partially septic field. This procedure heretofore has been done very insecurely and unreliably by gauze packs, which moisten and roll away from the position in which they were originally placed.

To ablate the flap is unsurgical and

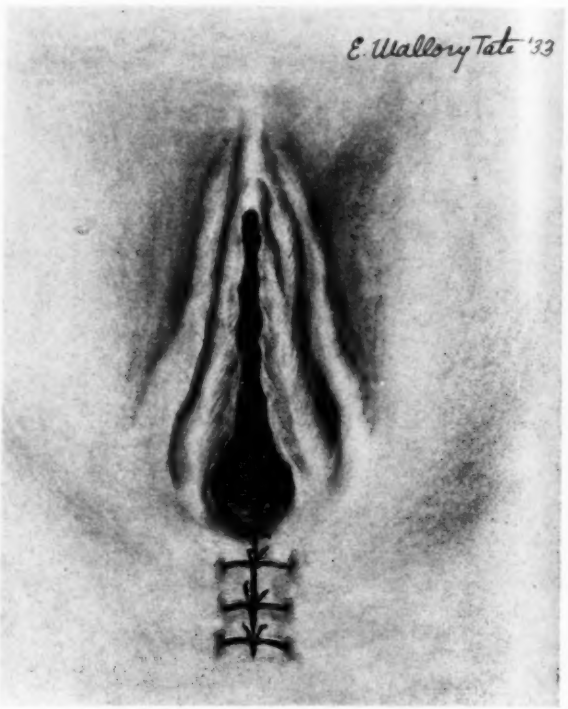

Fig. 6.

unphysiological, as there is just as much or possibly more need for the mucous covering in the vagina than existed before the laceration. The excision of this flap leaves a fore-shortened posterior vaginal wall, extending as a diaphragm from the upper portion of the sutured levator muscles toward the cul-de-sac and leaving a large dead space, triangular in shape, which is very unsurgical in principle and very susceptible to infection in practice.

I have used this suture a large number of times and it has been a great sense of satisfaction to see the apex of the vaginal mucous-membrane cone travel in its excursion to its final position, and to feel content that it is there permanently and snugly, leaving no dead spaces, and with all the raw surfaces in close apposition, insuring to the greatest possible degree the early healing and absence of infection.

To complete the repair, the transverse wound, from the posterior commissure toward the anus, is converted into a perpendicular slit by either silkworm gut or subcuticular sutures, whichever suits the fancy of the operator (see Fig. 6).

THE PROBLEM OF FUNCTIONAL UTERINE BLEEDING*

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UTERINE bleeding is the most common symptom with which the gynecologist has to deal. In many cases the most careful clinical examination fails to reveal any gross lesion. In spite of the absence of pathology the bleeding may be severe and the patient may almost reach the point of exsanguination. The studies to be reported in this paper deal with this variety which, for convenience sake, has been designated the functional type. At present there is no unanimity of opinion regarding the etiology of this condition. Among the etiological factors which have been suggested are uterine arteriosclerosis, inflammatory changes of the ovary and dysfunction of the organs of internal secretion.

In 1900 Thomas Cullen[2] described a benign hyperplasia of the endometrium which was associated with uterine bleeding. This condition was later described in detail by Novak and Martzloff.[7] The characteristic pathological change is an endometrial hyperplasia in which the irregularly dilated glands give to the section a Swiss cheese appearance. Schroeder[8] made an exhaustive study of a group of patients with this type of hyperplasia and has come to the conclusion that the condition is the result of an endocrine dysfunction manifested by cystic degeneration of the ovaries and by an absence of corpus luteum formation. In spite of much opposition, Schroeder's views are now generally accepted and his observations have been repeatedly confirmed.

Unfortunately, all cases of functional uterine bleeding do not exhibit the typical endometrial changes characteristic of the Swiss cheese type, and in spite of the importance of the problem and the recent advances in the study of the internal secretions, little has been done in an experimental way to solve it. Hofbauer[5] has produced a similar lesion in guinea pigs, by repeated injections of anterior pituitary substance, and concluded that the endometrial changes were due to a hyperfunction of the anterior lobe. Frankl[4] disagrees with Hofbauer's theory and believes that inflammatory and circulatory changes in the ovary are the more important etiological factors.

In considering the problem, one must realize that all endometrial changes are dependent on the endocrine activity of the ovary and that the usual microscopic examination of the ovaries fails to show the degree of functional activity of these organs. It is entirely possible that two histologically similar ovaries may have very different secretory rates.

At the present time there are two known ovarian secretions. One of these is derived from the interstitial and follicular apparatus and is known as estrin; the other is derived from the corpus luteum and is known as progestin. Others have shown the endometrial changes to be the result of the action of these hormones.

In attempting to study the problem of functional uterine bleeding, it seemed logical to consider the endometrium as reflecting the activity of the ovary. Hence, it became necessary to establish the endometrial pattern produced by ovarian extracts separately and in combination. Our first work[1] dealt with these questions and typical cellular patterns were found.

Having determined that estrin produces an endometrium which is in all respects

* Read before the Meeting of the Pan-American Medical Association in Dallas, Tex., March 23, 1933.

similar to that of the uterus from the first day of the menstrual cycle until the time of ovulation, and that estrin and progestin produce changes which are similar to those which occur from the time of ovulation until the beginning of menstruation, we were in a position to study specimens from functional cases in the light of these findings. Some of the functional cases have exhibited evidence of the action of progestin; the majority have shown varying degrees of estrin activity or have been frankly hyperplastic. Many were similar to the normal interval type of endometrium and transitional types were not uncommon. In the hyperplastic cases some of the glands were of the normal interval type but many were dilated. These facts lead us to believe that all cases of functional uterine bleeding which did not exhibit any progestational activity were of the same type, and that the variations were due to differences in the degree of estrin activity or to differences resulting from the length of the period during which there was increased estrin activity.

In order to test the validity of this conception, a further series of animals was used; these animals were injected with varying amounts of estrin over a longer period of time.[9] In this group we were able to produce many typical examples of cystic glandular endometrial hyperplasia of the so-called Swiss cheese type of Cullen and Novak. From these experiments it is apparent that all cases which bleed from an endometrium showing no evidences of progestational proliferation belong in the same group.

The diagnosis between functional uterine bleeding and cancer of the body of the uterus is not always easy, and most observers think such a differentiation can only be made by a study of the uterine scrapings. As a result of a limited number of hospital beds and an abundance of these cases in the Out-Patient Department, it has been impossible to admit many of them to the hospital for curettage. In order to overcome this difficulty, a small uterine cannula was made which could readily be passed into the uterus.[6] Suction was made from an attached syringe. In most instances a sufficient amount of tissue has been obtained to make a diagnosis without resorting to the use of the curette. The method is practically painless and causes no more discomfort than the passage of an ordinary uterine sound. More recently we have used a flexible specimen cup forceps, which was especially made for us. With this instrument at least two pieces of tissue can be obtained with each insertion. If the procedure is repeated daily for several days, seven to nine samples from different areas can be obtained. The more often the procedure is repeated, the less chance there is of overlooking a small circumscribed carcinoma. This method has been very satisfactory and has obviated the use of the curette for diagnostic purposes in many instances.

While much has been accomplished in the study and diagnosis of the disease, we have not arrived at its ultimate solution. It seems fairly certain that an ovarian dysfunction, whereby estrin is the only secretion produced, is the cause of the endometrial changes, but the explanation of this dysfunction is still unknown.

The relationships between the endocrine glands are complex and little understood. Hofbauer has shown that the disease can be produced by the over-activity of the anterior hypophysis. It would seem logical, therefore, to find the secretions of the hormone of the anterior pituitary in the urine of these patients, if this were a common cause. Fluhmann[3] and others have not been able to find it with any degree of regularity and I am of the opinion that it is frequently absent. It also seems somewhat strange that an increased function of the anterior hypophysis should take place at the time the patient nears the menopause, because the anterior hypophysis is generally considered as the stimulator of sexual activity and the menopause is considered as the cessation of the reproductive function. While admitting the accuracy of

Hofbauer's conclusion and the occurrence of an occasional case of this type, I am inclined to believe that they are a small minority.

It is a well-known fact that partial castration of rodents will result in the continuous production of estrus. In a group of these animals in which the ovarian tissue had been reduced to a very small amount, we were able to find several typical examples of endometrial hyperplasia and not infrequently the same thing has been observed in patients who have been partially castrated. I believe that the explanation of these facts lies in a better understanding of the relation between the hypophysis and the ovary. The hypophysis is the motivator of the sexual function, and estrin decreases the ovarian stimulative capacity of the anterior lobe. It is suggestive that a disturbance of this relationship has much to do with the etiology of functional uterine bleeding.

The treatment of these cases with extracts of the urine of pregnancy has proved very satisfactory in many instances, and I have found encouraging results similar to those which have been reported elsewhere. Many workers have assumed that the action of these extracts is due to the presence of corpora lutea. A study of tissue from cases treated with these extracts has shown that luteinization of the ovary, with a resulting progestational reaction in the endometrium, is not necessary for successful results.

While many of these cases are benefitted by this treatment, there still remains a very troublesome group which has not responded and which will require more radical measures. It is of course not necessary to discuss these well-known measures before such a distinguished group.

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THE OCCURRENCE AND POSSIBLE SIGNIFICANCE OF

ADENOMA OF THE GALL BLADDER

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ADENOMAS of the gall bladder are not often found either in surgical or necropsy specimens, and little if any importance has been attached to them. Only a few isolated cases have appeared in the literature.[1–4,7–11]

FIG. 1. Tumor in fundus of "strawberry" gall bladder.

The terminology of adenomas varies with the nature of the lesion and with its anatomic position. Pathologists and surgeons alike are prone to confusion with regard to the terminology, and the tumors have been variously called adenoma, adenomyoma, fibroadenoma, cystadenoma and papillary adenoma. I shall call them adenomas because those to which I refer are composed of glandular structures lying within the wall of the gall bladder.

This paper is based on a study of 69 adenomas found in a series of 9550 gall bladders removed surgically at The Mayo Clinic. All but four of the tumors were in the fundus. Two tumors were malignant and in the upper portion of the body of the gall bladder; one was near the neck and one was in the body. Sex was of little significance as 47 tumors occurred in female subjects and 22 in male subjects, and in view of the fact that cholecystic disease is two or three times more common among females. The presence or absence of calculi does not influence the occurrence of adenoma because 38 were associated with stones and 31 were without stones. One of the malignant tumors occurred with calculi and one without. However, the one without calculi was associated with empyema of the gall bladder in which there may have been a stone, but none was present at the time the gall bladder was removed. Adenomas were also found often in "strawberry" gall bladders and in gall bladders containing one or more papillomas.

Adenomas practically always occur singly, but 2 cases were noted in which there was more than one tumor. One gall bladder contained three small tumors near the mucosa in the fundus and body. These tumors are usually small, freely movable nodules in the wall of the gall bladder. They are semisolid and oval, and the larger ones have a dimpling in the center on the mucosal side (Fig. 1). They occupy part or all of the wall of the gall bladder between the mucosa and serosa. On cross section the glandular structure is clearly visible. Histologically, these tumors are composed of glandular struc-

tures which vary in size, shape and form, some large and cystic and others papillary (Fig. 2). The glands usually lie within the musculature of the wall of the gall bladder. There is almost always some evidence of inflammation in or near the tumor, as shown by the presence of scattered and collected lymphocytes and fibrous tissue. The glands are lined with tall columnar epithelium similar to that covering the villi of the mucosa. In some instances the cells are stained with bile, and in one case there were deposits of stony material. Sometimes one gland may become very large and distended with mucus, or one or more may become confluent and produce a large adenomatous cyst filled with mucus.

Fig. 2. Adenoma.

These adenomas may be placed in three groups: (1) the adult acquired or active type, which is by far the largest group; (2) the fetal, congenital or inactive type, which I have observed only in the form of heterotopic glands, and (3) a possible type, tumors composed of both the adult and fetal glands with a predominance of the adult glands. This classification may be compared to adenomas of the thyroid gland.[12] Embryonic rests may occur in the development of the gall bladder and later give rise to tumor. If such a tumor were found in the gall bladder of a fetus or young child, it would be similar to the so-called embryonic rests found in other organs such as the suprarenal rests in the kidney. The gall bladders in this series were all from adults.

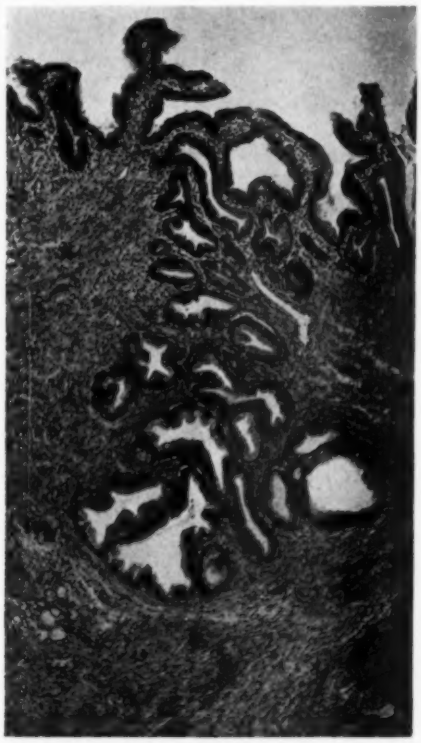

Fig. 3. Migration of glandular structure deep into wall of gall bladder.

This type of tumor, composed of larger glands lined by tall columnar cells is the more common of such tumors. If inflammation is present, glandular tissue frequently migrates into the wall of the gall bladder between muscle bundles (Fig. 3), producing the circumscribed but not encapsulated tumor which varies in size from 2 mm. to 2.2 cm. in diameter. The assumption that these tumors, aside from the supposedly embryonic rests, are common in the fundus of the gall bladder may be due to the belief that this portion of the gall bladder is weakest,

since tumor has been found in association with diverticulum. In the presence of inflammation, the inversion and subsequent migration of glandular elements takes place into the musculature. However, to offset this theory somewhat is the frequent finding of diffuse migration (heterotopic) of glandular elements throughout the wall of the gall bladder but without the formation of tumor.[5]

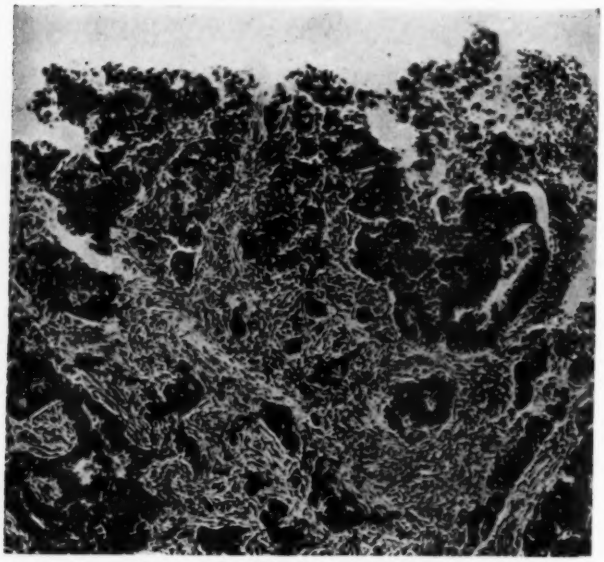

FIG. 4. Small adenocarcinoma.

Clinically, adenomas apparently are "silent," and the symptoms are usually referable to the accompanying cholecystic disease. Recently, however, Kirklin has been able to detect their presence by roentgenologic examination. Some of the pain experienced with mild cholecystitis could be attributed to these tumors.

The incidence of malignancy is low, being found in the 2 cases only on microscopic examination. The tumors appeared grossly as thickening or nodules measuring 2 and 8 mm. in diameter, respectively, and were situated in the upper portion of the body of the gall bladder. They were typical carcinomas differentiating into small glands lined by columnar epithelium, and invading the musculature and subserosa (Fig. 4).

In my opinion there are three ways in which an adenocarcinoma may originate: (1) it might start in the epithelium of the mucosa, proliferating into a polypoid lesion or producing a tumor with subsequent ulceration and migration into its wall; (2) a small group of adult or fetal heterotopic glands may become malignant, producing carcinoma instead of benign adenomatous tumor, or (3) a change to malignancy could easily be compared to the malignant regeneration in adenomas and sessile polyps of the large bowel. Carcinoma of the gall bladder usually occurs in the neck; however, carcinoma does occur in the fundus.

SUMMARY

In a series of 9550 gall bladders removed surgically at The Mayo Clinic, 69 contained one or more adenomas. Forty-seven of the patients were women and 22 were men. Thirty-eight of the tumors occurred in gall bladders containing stones and 31 in gall bladders without stones. These adenomas as incidental findings may play a part in the production of pain in cholecystic disease; they may be a possible source of carcinoma.

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MENSTRUATION AFTER ABDOMINAL OPERATIONS

ITS EARLY APPEARANCE AS A FAVORABLE PROGNOSTIC SIGN

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NEW YORK CITY

IT not infrequently happens in human experience that something that is very obvious escapes observation—something that is really too much on the surface to be seen. This fact is the basis of the well-known and entertaining detective-mystery of Edgar Allan Poe's, "The Purloined Letter." The situation, however, is not as fantastic nor as fictional as one might suppose, and has occasionally occurred in the history of medicine. I would here like to call attention to one of these overlooked commonplaces, with which I have been familiar for many years, but which, apparently, has escaped general notice, for, as far as I have been able to determine, it has never been referred to in the literature. Apparently, the phenomenon about to be described was also recognized by my former chief, the late Dr. Frederic Kammerer, with whom I repeatedly discussed it. He seemed to take it for granted that it was more or less generally known, but this, however, does not appear to be the case, as no one, among the many other surgeons to whom I have mentioned it, seemed familiar with it.

My observation is as follows: If a woman on whom an abdominal operation has recently been performed begins to menstruate, either at the time that corresponds to her regular period or especially before her regular period, it is almost a certainty that the postoperative course will be smooth and uneventful. This sign seems to be so consistent and so nearly infallible, that no matter how critically ill the patient may have been, or how serious the operative procedure was, as soon as the nurse reports that the patient is menstruating, I have the comfortable feeling that in this particular case there is nothing further to worry about, even, as I have frequently observed, when other unfavorable symptoms persist for a time. Further, the smoothness of the convalescence seems to be in direct proportion to the promptness of the postoperative appearance of the menstrual flow. In other words, if the flow appears, let us say the day after operation, and particularly if the appearance is before it is normally due, the convalescence will be especially uneventful, although its non-appearance does not necessarily indicate an unfavorable prognosis.

When one analyzes the sign, there is nothing so remarkable about it, and it is what one would naturally expect as a purely physiological manifestation. It is quite comparable with the normal restoration of the peristaltic function of the intestine, which has been regularly observed and stressed after abdominal operation. This return of the normal function of the intestine has, as is well known, been looked upon by surgeons as a very favorable sign, and, when it occurs and the patient is expelling flatus normally, and the usual postoperative distention subsides, the danger of peritonitis is regarded as more or less over. Similarly but less markedly, the resumption of bladder function also indicates a favorable progress as regards local conditions in the abdomen. On a physiological basis, the obvious explanation of these observations is that irritative or inflammatory disturbances in the abdomen are naturally inhibitive toward the functions of the various organs. Operative trauma, infection and peritonitis produce paralytic ileus due to paresis of the intestinal muscularis and, to a lesser degree because the organ has more of an extraperitoneal position, affect the contractile power of the urinary bladder. It is quite logical to assume that serious

intra-abdominal disturbances would have the same inhibitory effect upon the ovaries and the menstrual phenomenon. Therefore, if menstruation appears, it is logical to assume that there is no very serious disturbance going on, and the sooner it appears, the less was the prior disturbance and the less chance of development of further trouble. Conversely, and confirming this observation and theory, it has also been my experience that serious acute abdominal disturbances, independent of operation, such as an attack of acute appendicitis or a gastric or an intestinal perforation, almost invariably cause a delay of a menstrual period that is due or the arrest of one that is present at the time, just as it inhibits the peristaltic action of the intestines. Even in extra-uterine pregnancy, where irregular metrorrhagia is a common symptom, when the rupture occurs and intra-abdominal hemorrhage supervenes, the metrorrhagia usually ceases. Further, one frequently sees an existing menstrual period promptly arrested by an intercurrent abdominal operative procedure, and also the return of menstruation considerably delayed, often for months, after even a most successful abdominal operation, which has seemingly run the smoothest possible course.

Still further, it appears that this menstrual prognostic indicator is, if anything, a more delicate and earlier one than even the return of intestinal peristalsis or bladder function. This is possibly because the ovarian function is peculiarly sensitive to external stimuli, or, perhaps, because of the anatomical fact that the ovary is actually the only true intraperitoneal organ, unprotected by a real serous covering, and is therefore much more directly exposed and susceptible than either the intestine or the bladder to intra-abdominal insults, and likewise more promptly responsive to the restoration of normal conditions in the abdomen. Whatever the theoretical explanation may be, practically, the sign is unusually dependable, and its appearance will spare the surgeon many an anxious moment. Of course, it is mainly of value as regards the development of postoperative peritonitis or the progress of a peritonitis that existed before operation. After, for instance, an operation for a virulent acute gangrenous appendicitis with spreading peritonitis, or for an acute intestinal obstruction, it seems quite safe to assume that the patient's progress will be very satisfactory if she menstruates a day or two after operation, even if her abdomen is still somewhat distended and sensitive, even if she has not yet passed gas, even if she cannot void and must be catheterized, even if she is still vomiting, and even if her pulse and temperature have not yet come down. My experience has been that the fact that she is menstruating is definite proof that the abdominal process is recessive and, as soon as the menstrual flow begins, all other unfavorable symptoms will soon subside, and convalescence thereafter will be comparatively uneventful.

I have seen this so frequently and so reliably demonstrated that, to my mind, there is no doubt whatsoever about the significance of this sign. While its value seems to apply particularly to the question of peritonitis, as a matter of practical fact, in my entire experience, I can recall only two instances, in which the menstrual flow appeared early after abdominal operation, where there has been any real trouble. The first, the only intra-abdominal disturbance which I have encountered, was a fatal postoperative intestinal obstruction, occurring eleven days after a myomectomy, appendectomy and hysteropexy. This developed in spite of the fact that two days after operation the patient had begun to menstruate and, accordingly, had been pronounced out of danger. The obstruction, verified by reoperation, was a late and sudden development during the course of what was apparently an exceptionally uneventful convalescence, was due to a mass of dense adhesions involving the lower ileum, and was an accident of a purely mechanical character. The second was a relatively

mild left femoral phlebitis, developing eight days after a cholecystectomy and appendectomy. The patient had a very peculiar immediate postoperative reaction with a rise of temperature to 105.2°F. and pulse to 150 sixteen hours after operation, without any other untoward symptoms except excessive nervousness. This was very suggestive of a thyrotoxicosis, which occasionally occurs after an abdominal operation, even when there is no previous evidence of active hyperthyroidism, as was the situation in this case. Under Lugolization, the condition promptly subsided and three days after operation the patient began to menstruate normally for her usual period of three days, and was apparently making a good recovery when the femoral phlebitis developed. The phlebitis rapidly resolved and the convalescence thereafter was quite uneventful. Aside from these two cases, I have never seen any other serious local or remote postoperative disturbance, such as progressive peritonitis, paralytic ileus, acute dilatation of the stomach, abscess formation, real wound infection, secondary hemorrhage, pulmonary embolism or pneumonia, after the early appearance of menstruation.

EFFECT OF RADIO KNIFE ON WOUND HEALING

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FOR primary union to occur in any wound it is essential that the surfaces be agglutinated first by the development of fibrillar fibrin in the plastic exudate between them. Hertzler[1] has shown that by a chemical change this fibrin is converted into collagenous fibrin (Fig. 1). Monocytes wander into this, elongate and flatten out parallel with the strands and become the so-called fibroblasts. Thus adult repair tissue is formed.

FIG. 1. *a,a,* Muscular wall of two loops of intestine whose surfaces have been mildly irritated and held in apposition with silk suture. *b,* strands of fibrin agglutinating surface. Specimen is seven days old and fibrillar fibrin has changed almost completely to collagenous fibrin.

In the practical application of cutting tissue by the radio knife it is necessary to use a current with some coagulation property or it is of no value as a hemostatic. Tissue cut in this way and examined under the microscope is seen to be covered by a thin membrane of coagulum varying in thickness according to the amount of dampening of the current used (Fig. 2). This serves to separate the surfaces of the viable tissue and until it is sloughed off or cleaned up by phagocytosis fibrillar fibrin cannot unite them. To expect then that primary healing will occur in these wounds is contrary to the fundamentals of the process.

From the practical standpoint this theoretic difficulty does not occur regularly under all conditions and depends on the apposition of the wound with the coagulum membrane intact on its surface. If we operate through the skin into the deep tissues, using the radio knife for cutting, the skin is likely to be sutured together with this membrane actually separating them. Experience has taught us that the skin fails to unite in a high percentage of cases as rapidly as normally expected. In experimental skin wounds Ellis[1] found only 60 per cent to heal by primary union when the radio knife was used for making them. Ninety-seven and a half per cent

[1] Hertzler, A. E. The Peritoneum. St. Louis, Mosby, 1919.

[1] Ellis, J. D. *Surg. Gynec. Obst.*, 52: 516, 1931.

healed by primary union when the incision was made with a sharp scalpel.

The deep tissues as fat and muscle seem to unite better when cut with the radio knife. This is probably due to the handling of the tissue during the surgical procedure with the result that the coagulum on the surface is rubbed off and buried in the tissue. Where this occurs primary union may take place. If we attempt to reopen the wound several days after it has been closed we often notice areas where union is normally good, others where it is delayed. In the latter cases the surfaces have not been united because of the intervening coagulum.

Also it is well to remember that if the radio knife was thoroughly efficient in sealing the tissue spaces and preventing all oozing of serum into the wound there would be no plastic lymph present for the initial process of healing. While this is not the case with the currents now generally used for cutting, it would be kept in mind in any effort toward developing an apparatus capable of cutting with complete hemostasis. Some biopsy loops and underwater cutting currents now in use seem actually to do this.

Fig. 2. Muscle through which radio knife was passed five days before killing animal. *a*, layer of coagulum separating viable tissue, *b,b*.

The results obtained in practical use will finally determine the value of electrosurgery. While it has added without doubt something of worth to our operating equipment, the amount of this is yet to be seen. Caution must be exercised against drawing hasty conclusions in the matter without an understanding of the fundamentals involved.

SUMMARY AND CONCLUSIONS

Agglutination of tissue surfaces by fibrillar fibrin developing in plastic exudate is essential to primary wound healing. This cannot be expected to occur in wounds made by the radio knife unless the coagulum formed on the wound surfaces is removed. Wound healing will be retarded in direct proportion to the efficiency of the electric knife in producing hemostasis.

INJECTION TREATMENT OF HEMORRHOIDS*

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MORGAN of Dublin[1] in 1869 was the first to use a solution of persulphate of iron in the injection treatment of hemorrhoids. This method of injection therapy, as reported by Anderson,[1] had been used in the treatment of nevi since 1836.

Edmund Andrews[2] stated that Mitchell of Clinton, Illinois, in 1871, conceived the idea of treating hemorrhoids by the hypodermic injection of a mixture of carbolic acid and olive oil. It was a secret method and the right to practice it, together with the formula, could be bought by anyone. It thus came about that blacksmiths, drug clerks, farmers and quacks obtained knowledge of this method and they began to recklessly and indiscriminately inject every anorectal condition that fell into their hands. It was not long before travelling mountebanks began injecting carcinoma and polypi, thereby "curing" the countryside of piles. The method fell into disrepute, and regular practitioners condemned the procedure. All this took place about sixty years ago.

Andrews[2] collected 3304 cases from this type of practitioners, with the following results:

Deaths	13
Embolism of liver	8
Sudden and dangerous prostration	1
Abscesses of liver	1
Dangerous hemorrhage	10
Permanent impotence	1
Stricture of the rectum	2
Violent pains	83
Carbolic acid poisoning	1
Failed to cure	19
Severe inflammation	10
Sloughing and other accidents	35
	184

The wonder is that the results were not worse, but of course, we must consider the source of the information of these statistics.

In 1925, E. H. Terrell[3] of Richmond, Virginia, presented to the American Proctologic Society his paper on the "Treatment of Hemorrhoids by Injection." He began his work in 1913 and he had treated over 3000 cases by 1925. In his paper he made the logical observation that although the condemnation of the results was justifiable, the fault lay with the people who used the method rather than with the method itself. He further observed that it was truly remarkable that the method survived at all under those circumstances; all of which is good evidence that there is something of value in it.

Up to 1913, although a variety of chemicals was used, carbolic acid in various strengths and combinations was the solution of choice. As a matter of fact it is still extensively used here and abroad. In 1923 Morley[4] published a book on hemorrhoids. He advocated injections with 20 per cent solution of carbolic acid in equal parts of glycerine and water. In 1913 Terrell[3] introduced the use of urea and quinine, 5 to 10 per cent solution.

When we established the rectal clinic at The Brooklyn Hospital in 1925, urea and quinine hydrochloride was decided upon because we felt that we would be less apt to run into complications than if carbolic acid were used. We have used phenol 5 per cent in either C. P. cottonseed or almond oil with results as good as with urea and quinine hydrochloride. We prefer a solution of the latter because it is less troublesome to handle, and our experience with it has been most gratifying.

RATIONALE OF THE INJECTION METHOD

The object of the injection treatment of hemorrhoids is to set up an inflammatory

* From the Surgical Service, Division of Proctology, Brooklyn Hospital, Dr. Ernest K. Tanner, Chief Attending Surgeon. Read before the Sixth Annual Joint Meeting of the Italian Medical Society of Brooklyn with the Association of Italian Physicians in America April 17, 1933.

reaction within the hemorrhoidal mass, thereby causing an obliteration of its vessels by thrombosis followed by fibrosis.

habits and general physical status must be taken into consideration.

Morley[4] and Anderson[1] in England,

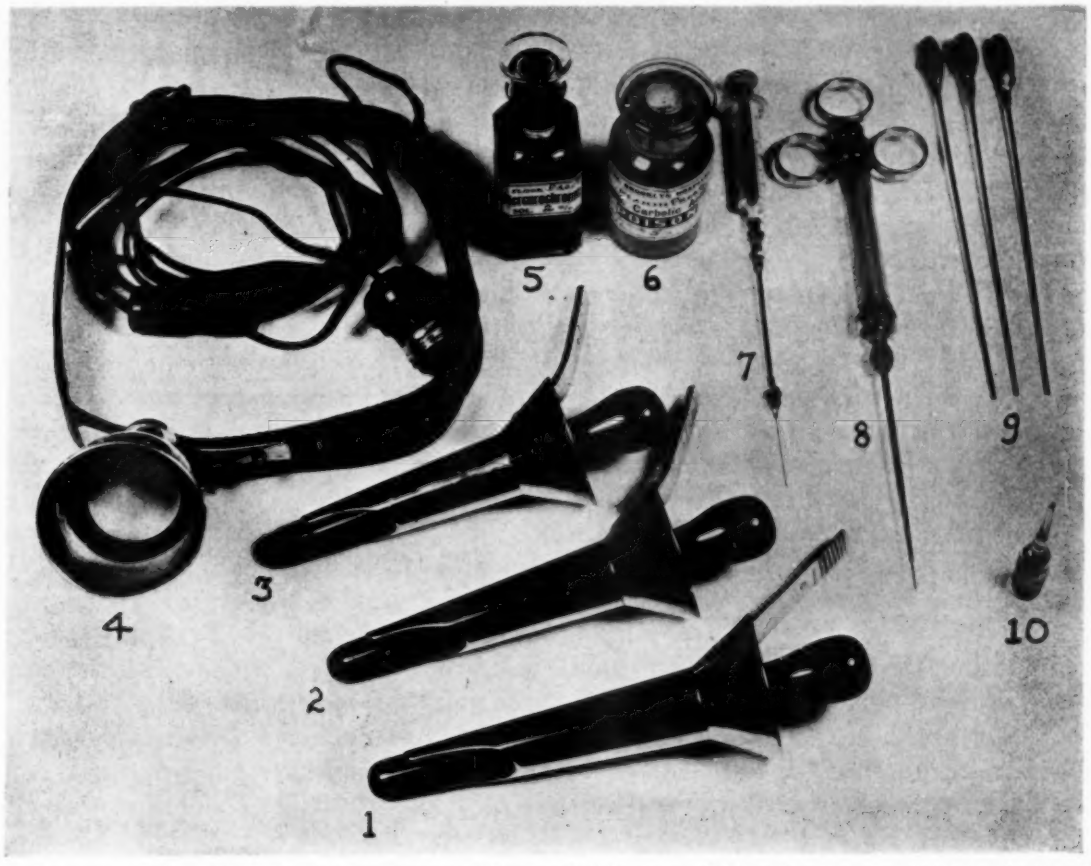

Fig. 1. Armamentarium for injection treatment of hemorrhoids. (1, 2, 3) Set of anoscopes; (4) Murphy headlight; (5) mercurochrome 2 per cent solution; (6) carbolic acid 5 per cent in almond oil; (7) 2 c.c. Luer syringe with extension shank and 24 gauge needle (for injecting 5 per cent urea and quinine hydrochloride); (8) Vim syringe with long needle (for injecting 5 per cent phenol in almond oil); (9) swabs; (10) 2 c.c. ampule of 5 per cent urea and quinine hydrochloride.

The injection can be made either into the substance of the pile tumor, or just above the hemorrhoid and immediately underneath the mucosa, that is, submucously. In either event the injection is not made into the blood vessels but into the tissues surrounding them.

SELECTION OF CASES

The prime requisite is a proper diagnosis. Treatment of any anorectal condition should never be attempted without a proctoscopic examination, besides the usual inspection and digital exploration.[5] The patient's occupation, temperament,

and Terrell,[3] Hirschman,[6] Yeomans,[7] Fansler[8] and other exponents of the injection method in this country, all agree that external hemorrhoids should never be injected. We have seen external piles so treated and the results have been such as to require surgical intervention. This injection method is applicable only to uncomplicated internal hemorrhoids, and it is suitable to only 50 per cent of cases seen. If the condition is complicated by fistula, fissure, polypi, hypertrophied anal papillae, cryptitis, anal or rectal tumors, it would be useless to treat the hemorrhoids by injection, for these conditions require surgery and the hemorrhoids can be removed at

the same time. Thrombosed, ulcerated, strangulated and gangrenous or fibrotic cases demand surgery; injection therapy is contraindicated.

ARMAMENTARIUM

This consists of a suitable anoscope, a good light, suitable syringe, and solutions.

We have developed an anoscope in our clinic which has been found the most useful for our purpose and which is used for either examination or treatment. It consists of a chromium-plated metal conical cylinder with a slot and a flange to which the handle is attached. Introduction is made easy with a perfectly fitted hard rubber obturator. To suit the variable types of anus and length of the anal canal, the instrument comes in three sizes as shown in Figure 1. There are some characteristics of these specula which are worth mentioning. The angle and width of the flange is so built as to help retract large buttocks. The difficulty with most anal instruments is that the buttocks fold in over the opening of the speculum. The handle comes from the flange at the same angle as the latter so that the instrument can be inserted its full length without being impeded at the handle region by large buttocks.

The slot is of uniform length in all three sizes, but the cylindrical portion of the instrument is made of graded varying lengths so that the smallest is 2 inches long, the next is 2½ inches long and the largest is 3 inches long. Thus we have a suitable instrument for a short, a medium sized or a long anal canal. There are people who have a short anal canal but with funnel shaped buttocks. In these people the largest anoscope is the only one which will properly expose the terminal rectum. The slot is 11/16 of an inch at the terminal end, semilunar in shape at the proximal end and 1½ inches long. One-quarter of the circumference of the terminal rectum and anal canal can be exposed with ease, and the construction of the instrument is such that it can be rotated while inserted without the necessity of withdrawal and reintroduction.

TECHNIQUE AND PROCEDURE

Anesthesia is not employed. A cathartic or enema is not given before each treatment, for we have found that their action usually takes place when manipulation of the anorectal region is begun. We prefer to have our patients report without preparation. With the patient in the inverted, knee-chest or in the Sim's position, whichever is best suited to the patient, an anoscope of our set is selected according to the requirements and it is inserted to expose the hemorrhoids. It makes little difference whose anoscope is used, but we prefer the one which we have developed. Good illumination is necessary.

The largest pile is selected and the anoscope is steadied in position. If a bleeding pile is present, that takes precedence over the others. A large swab is used to cleanse the mucosa of mucus, particles of feces or blood. The exposed area is next painted with 2 per cent mercurochrome. Perhaps that is a futile gesture so far as sterility is concerned, but we at least have the feeling that we do not introduce infection through the mucosa when the solution is injected. A 2 c.c. Luer syringe is employed with a 24 or 25 gauge needle on an extension shank. The syringe is charged with 5 per cent urea and quinine hydrochloride. The needle is plunged into the uppermost part of the hemorrhoidal mass and inserted to a depth as near the center of the mass as it is possible to gauge. The depth of introduction of the needle, of course, depends upon the size of the mass. Before injection is begun it is well to withdraw the piston to make certain that a vessel has not been entered.

The injection is made slowly and enough solution is used to distend the hemorrhoid moderately, without blanching. We feel that it is safer to err on the side of injecting too little. From ½ to 2 c.c. of solution may be necessary to distend the mass.

The needle is permitted to remain in situ for thirty seconds or more to prevent leakage of solution. If the injection is properly done there is no immediate pain. A transient feeling of fullness in the rectum follows the introduction of the solution. It is well to insert the finger into the rectum and with gentle massage of the injected area spread the liquid immediately after the injection.

If the patient is attending to duties which require much activity, only one hemorrhoid is injected at a sitting. If, on the other hand, the patient is not actively engaged, then two or more hemorrhoids, or if they are small, all the internal hemorrhoids that are present, may be injected at the same sitting.

If there is any tendency to prolapse of rectal mucous membrane, instead of injecting into the pile mass, we insert the needle just above the pile through and underneath the rectal mucous membrane, and the solution is injected submucously.

The interval between injections is usually one week, but in cases where the hemorrhoids are not very large, two injections per week may be given. One injection may cause a pile to disappear, but at times a second injection is necessary. Before a pile is re-injected it should be determined by digital examination that no induration is present. The induration must subside before the second injection is given.

From six to eight treatments may be necessary before the hemorrhoidal masses disappear, which means that it takes from three to eight weeks to complete a course of treatments. A chart is kept to record the site and date of each injection and the quantity, strength and kind of solution. A circle, the circumference of which is divided into four or eight equal parts, suffices for this purpose.

AFTER-CARE

The patient is instructed to avoid severe physical effort. Mineral oil is given by mouth to make bowel movements easier. Regular diet is permitted. The patient is warned to replace immediately any protrusion which may occur.

COMPLICATIONS

Idiosyncrasy: Before beginning treatment, it is well to determine the patient's susceptibility to quinine. We know of nothing more disconcerting than to have a patient have a convulsion in the office. Where such susceptibility exists, we use 5 per cent phenol in vegetable or almond oil instead of urea and quinine hydrochloride.

Pain: There should be no pain at the time of injection if the treatment is properly given. If the injection is given without regard to the anatomy of the anorectal region, pain is sure to ensue. Most certainly, the solution must not be injected into the anal canal nor in such a way as to encroach upon the anal valves or crypts of Morgagni. If the needle is not plunged high enough up in the terminal rectum, some of the solution will trickle down or gravitate and find its way beneath the covering of the anal canal. To avoid pain it is necessary to inject slowly and well above the dentate line.

Bleeding: At times, bleeding may occur after withdrawal of the needle. This bleeding usually stops of its own accord or can be checked by pressure. Very infrequently bleeding may be such as to require electrocoagulation or even clamping with ligation. Morley[4] cites one case where he was unable to check bleeding with clamping and he had to pack the rectum. Suture ligature may be necessary; and then, of course, the method is no longer painless. Bleeding sometimes may follow sloughing.

Slough: Too large an amount or too strong a solution will result in slough. We advise the use of a weaker solution even if one must re-inject rather than the production of a slough through using too strong a solution. Injection into the mucous membrane or muscle or into a hemorrhoidal mass which is still indurated

from previous treatment will result in slough.

Unreduced Prolapse: A prolapsing pile can usually be injected in such a way as to make prolapse almost impossible, but some will prolapse no matter what is done. It is very important to warn the patient about replacing a prolapse if it should occur, for if the pile is allowed to remain down, strangulation and gangrene will follow.

Stricture: This can follow cicatrization as a result of slough, or through tumefaction of indiscriminate injection of oil.

Infection: The presence of infection in the anorectal region is a contraindication for injection, for although the rectum is peculiarly resistant to infection, an abscess may form. Submucous, perirectal, perianal or marginal abscess formation may be followed by fistula.

Recurrence: It has been estimated that recurrences in two to five years occur in about 15 per cent of the cases. It must be borne in mind, however, that inasmuch as the treatment is painless, gives symptomatic relief, and does not detain patients from their duties, they feel kindly toward the treatment and will return for another course, if necessary, without condemning the method.

CONCLUSIONS

We have a valuable means at our command of treating uncomplicated internal hemorrhoids. This method demands the attention and respect of every practitioner of medicine, and although, according to Jelks,[9] it may have been "conceived in quackery, hatched in quackery and nurtured in quackery," honest evaluation makes it most acceptable when used with discretion. The method is not without danger, and has its limitations which must be understood before its use is undertaken. Surgical judgment as well as skill and knowledge are essential, for although the method seems simple, unless one understands the rationale and technique, disappointment and complications result. When complications arise, the treatment becomes worse than the disease, and convalescence is longer than if a surgical operation had been performed.

The method will never replace a properly performed hemorrhoidectomy but it has a place in the debilitated and anemic, the diabetic, the aged, and in that large group who refuse hospitalization and surgical operation. It is valuable, also, for internal hemorrhoids complicating pregnancy, but instead of the quinine preparation in these cases, a solution of carbolic acid should be used for obvious reasons.

Finally, we know with what horror a patient looks upon the prospect of reoperation for recurrence of any condition. In this method, we have a most satisfactory means of dealing with hemorrhoids recurring after hemorrhoidectomy.

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A BACTERIOLOGICAL APPRAISAL OF 34 COMMONLY USED ANTISEPTICS*

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WITHIN recent years, there have appeared in the markets of this country a host of new products of claimed antiseptic, germicidal, or disinfectant properties, designed for professional and lay use. Some of these have been heralded to the laity as well as the medical fraternity through appealing radio programs, powerful and well-directed advertising campaigns, and fluent detail men. And from this array of antiseptics, for which science is alleged to have ascertained their strength in terms of pure carbolic acid; to have determined not only the speed with which they kill microorganisms, but even the number of germs killed in a given period of time, often but a matter of a few seconds; to have investigated and appraised the toxicity of the substance, not only to the tissue locally concerned, but more remotely to the body as a whole; to have measured the degree of penetrability, stating neither the penetrability of what nor the penetration of which, as well as staining characteristics, odor properties, corrosiveness of metal and rubber instruments, etc., etc.,—the doctor and his less informed lay brother is asked to make his selection of a universally applicable antiseptic.

This paper, then, is the result of a disinterested effort to compare, under approximately identical conditions, the merits of thirty-four commonly used antiseptics, and to present these results to the medical profession. so that they may appraise, under the conditions of this investigation, the relative merits of the several substances herein displayed. The scope of this paper is broader than that of any of its predecessors.[2–5] Four comparative procedures are used as subsequently described, and four different test organisms are employed.

Preliminary to presenting the results, with comments thereon, of the several procedures, a short reference to the technique used herein is offered:

"*F. D. A. Method.*" This procedure, the method of the United States Food and Drug Administration, is described in Circular 198 of the United States Department of Agriculture.[1] This method was followed exactly, except: three time exposures (five, ten, fifteen minutes) were arbitrarily selected for each organism and antiseptic; each individual experiment was not controlled with phenol, and no phenol coefficients were determined. The organisms, media, etc. conformed to the standards herein prescribed.

"*A. W. Method.*" The method devised,[4] and revised,[5] by Allen and Wright was followed exactly, and no exceptions occurred.

The Penetration, or agar cup plate method, was devised by L. C. Himebaugh,[1,5] and was followed exactly, except that one serum-agar (50 per cent serum agar) was used in place of the several dilutions suggested, and that the antiseptic solution used was removed from the cup at the expiration of five minutes only.

Skin Sterilization Method. This procedure requires explanation, and is herewith described, it is believed, for the first time.

With the antiseptic or skin disinfectant to be tested, paint the area about the metacarpophalangeal joint. Immediately dip the finger in a vessel containing the same antiseptic or skin disinfectant, so that the solution covers the entire finger, and

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overlaps the previously painted joint. Withdraw the finger after complete immersion in the solution. The time of immersion is not to exceed one minute. Allow the finger to dry. Immediately thereafter, pull on a dry sterile rubber glove, two sizes larger than that ordinarily required by the subject. Just distal to the metacarpophalangeal joint apply a rubber band just sufficiently tight to hold the glove in apposition with the finger at this junction, but not sufficiently tight to impede circulation. Immediately plunge the gloved hand into a basin of warm (105° F.) 1:1000 solution of mercuric chloride. Maintain the gloved hand in this solution for five minutes. At the expiration of this period of time, withdraw the gloved hand, and insert between the rubber of the glove and the skin of the finger tip a sterile, 22–25 gauge hypodermic needle attached to a sterile 2 c.c. hypodermic syringe loaded with 1 c.c. of sterile nutrient broth.[1] Inject and withdraw this nutrient broth solution several times. One-tenth c.c. of this broth wash is added to 10 c.c. of sterile nutrient broth. One-tenth c.c. of this broth culture is mixed with 10 c.c. of melted nutrient agar[1] and poured into a petri plate. This is incubated twenty-four hours. Plates showing no growth are reported as negative, or as demonstrating of skin sterilization.

Discussion of this method. The rubber band application prevents leakage of the solution back onto the non-medicated skin. If the glove used is too small, it is impossible to insert the full 1 c.c. of broth without forcing the solution beyond the rubber band. Placing the hand in the hot solution of bichloride of mercury causes the hand to sweat, bringing to the surface sweat and contaminants of the skin and pores. The bichloride solution is used because it is antiseptic itself, and prevents contamination of the exterior of the glove.

The media used, both the broth and the agar, are described under the F.D.A. method.[1]

It has been demonstrated repeatedly that an insufficient amount of antiseptic is carried over in the washings of the gloved hand to the subculture tubes to be in bacteriostatic concentration.

With but four exceptions, all of the drugs used in this study were received from the hospital pharmacy. Those of the proprietary type were obtained in the original, unopened packages; while the galenicals were made up according to the formulae noted. Below is appended the list of the preparations used, with their respective dilutions noted:

Alcohol, ethyl, 90 per cent, 85 c.c. of 95 per cent ethyl alcohol, 15 c.c. distilled water
Alcohol, ethyl, 70 per cent, 74 c.c. of 95 per cent ethyl alcohol, 26 c.c. distilled water
Alcohol, ethyl, 60 per cent, 65 c.c. of 95 per cent ethyl alcohol, 37 c.c. distilled water
Alcohol, isopropyl, pure, full strength.
Silver nitrate, U.S.P.X. 2 per cent
Silver nitrate, U.S.P.X. 1 per cent
Benzine, ordinary commercial grade
Gasoline, ordinary commercial grade
Ether, U.S.P.X.
Tincture of green soap, U.S.P.X.
Hydrogen peroxide, U.S.P.X., full strength
Mercuric chloride, 1: 1000 solution
Merthiolate, 1:1000 solution, full strength
Merthiolate, 1:1000 tincture, full strength
Mercurochrome, 220 soluble, 2 per cent aqueous solution.
Mercurochrome, 2 per cent "A.A.A." 35 c.c. distilled water, 0.1 gram sodium carbonate, 55 c.c. 98 per cent ethyl alcohol, 10 c.c. acetone, 2 grams mercurochrome—220 soluble.
Metaphen, 1:500 full strength
Metaphen, 1:2500 full strength
Oxyquinoline sulphate, 1.0 per cent solution
Phenol, U.S.P.X. 2 per cent solution
Liquor hexylresorcinolis (S.T. 37), full strength
Neutral acriflavine, 0.10 per cent aqueous solution.
Picric acid, U.S.P.X. 1 per cent aqueous solution
Liquor cresolis compound, U.S.P.X., 2 per cent
Clymocol, pure, full strength solution (Merck & Co.)
Clymocol, 1:50
Iodine, 7 per cent tincture, U.S.P.X.

Iodine, 3.5 per cent tincture, iodine, grams 3.5, potassium iodide, grams 2.5
Iodine, 5 per cent aqueous, iodine, grams 5, potassium iodide, grams 10.
Iodine, Davis, from the Davis Emergency Equipment Company, Inc.
Iodine, isotonic solution, Mellon Institute[6]

Chart 1

Food and Drug Administration method of testing antiseptics.

(Figures refer to time in minutes of exposure of organisms to antiseptic. Plus indicates growth, or lack of antiseptic qualities; minus indicates no growth or antiseptic properties.)

	S. Aureus			S. Albus			S. Hmlytus			B. Typhosus		
	5	10	15	5	10	15	5	10	15	5	10	15
Alcohol 80 per cent ethyl	−	−	−	−	−	−	−	−	−	−	−	−
Alcohol 70 per cent ethyl	−	−	−	−	−	−	−	−	−	−	−	−
Alcohol 60 per cent ethyl	−	−	−	−	−	−	−	−	−	−	−	−
Alcohol isopropyl	−	−	−	−	−	−	−	−	−	−	−	−
Silver nitrate 2 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Silver nitrate 1 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Benzine	+	+	+	+	+	+	+	−	−	+	−	−
Gasoline	+	+	+	+	+	+	+	+	+	+	+	+
Ether	+	+	−	+	+	+	−	−	−	−	−	−
Tincture green soap	−	−	−	−	−	−	−	−	−	−	−	−
Hydrogen peroxide	−	−	−	−	−	−	−	−	−	−	−	−
Mercuric chloride 0.1 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Merthiolate 1:1000 sol	−	−	−	−	−	−	−	−	−	−	−	−
Merthiolate 1:1000 tinct	−	−	−	−	−	−	−	−	−	−	−	−
Mercurochrome 2 per cent Aq'us	−	−	−	−	−	−	−	−	−	−	−	−
Mercurochrome 2 per cent A.A.A	−	−	−	−	−	−	−	−	−	−	−	−
Metaphen 1:500	−	−	−	−	−	−	−	−	−	−	−	−
Metaphen 1:2500	−	−	−	−	−	−	−	−	−	−	−	−
Oxy quinoline sulfate 1 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Phenol 2 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Liq. hexyl resorcinolis S.T. 37	−	−	−	−	−	−	−	−	−	−	−	−
Neutral acriflavine 0.1 per cent	−	−	−	+	+	−	−	−	−	−	−	−
Picric acid 1 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Liquor cresolis comp. 2 per cent	+	−	−	−	−	−	−	−	−	−	−	−
Clymocol	−	−	−	−	−	−	−	−	−	−	−	−
Clymocol 1:50	−	−	−	−	−	−	−	−	−	−	−	−
Iodine 7 per cent tincture	−	−	−	−	−	−	−	−	−	−	−	−
Iodine 3.5 per cent tincture	−	−	−	−	−	−	−	−	−	−	−	−
Iodine aqueous sol. 5 per cent	−	−	−	−	−	−	−	−	−	−	−	−
Iodine (Davis)	−	−	−	−	−	−	−	−	−	−	−	−
Iodine isotonic sol	−	−	−	−	−	−	−	−	−	−	−	−
Zonite 1:2	−	−	−	−	−	−	−	−	−	−	−	−
Zonite 1:4	−	−	−	−	−	−	−	−	−	−	−	−
Chlorazene	+	−	−	+	−	−	−	−	−	−	−	−

Zonite, 1 part zonite, 2 parts of water
Zonite, 1 part zonite, 4 parts of water
Chlorazene, 1 tablet to 1 ounce of water as directed.

DISCUSSION

"F. D. A." Chart. This is the procedure employed by the Federal Food and Drug Administration to determine whether or not a given product possesses antiseptic properties. It is a laboratory process admirably suited to the purpose of eliminating products having no bacteriostatic properties. It predicates no clinical results, and in no way simulates clinical experience. Yet, to a very large extent, this method of evaluation is the basis on which rests the large amount of advertising relating to practically all antiseptics.

Briefly outlined, this procedure consists of adding approximately 0.5 c.c. of a twenty-four-hour broth culture of the test organism to 9.5 c.c. of the antiseptic to be tested. At the expiration of five, ten, fifteen minutes of

contact between the test organism and the antiseptic under investigation, a "loopful" of this mixture is transferred to a tube of sterile nutrient broth and the whole incubated for forty-eight hours, at which time the tubes are inspected for growth or no growth. In Chart I the figures refer to the time of exposure. The plus sign indicates growth, while the minus sign refers to absence of growth.

them immediately and completely available to the antiseptic. Clinically, such a situation is without parallel. The "A. W." method was devised, then, to determine the antiseptic properties of these substances in the presence of massive infection and contamination, where the organisms were present in large numbers, actively growing, and not readily available to the action of the antiseptic substance.

CHART II

ALLEN WRIGHT METHOD.

(A = subcultures from twenty-four hour slant; B = subcultures from immediately inoculated slant. Figures refer to time in minutes of exposure of culture to antiseptic. Plus indicates growth; minus indicates no growth.)

	Staph'cus A			Aureus B			Staph'cus A			Albus B			Strept. A			Hemolyticus B			Bacillus A			Typhosus B		
	5	10	15	5	10	15	5	10	15	5	10	15	5	10	15	5	10	15	5	10	15	5	10	15
Alcohol 80 per cent ethyl	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Alcohol 70 per cent ethyl	+	+	+	−	−	−	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Alcohol 60 per cent ethyl	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Alcohol isopropyl	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Silver nitrate 2 per cent	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Silver nitrate 1 per cent	+	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Benzine	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gasoline	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ether	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	+	−	−	−	−	−
Tincture green soap	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Hydrogen peroxide	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Mercuric chloride 0.1 per cent	+	−	−	−	−	−	+	+	+	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−
Merthiolate 1:1000 sol	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−	−	−	−
Merthiolate 1:1000 tinct	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Mercurochrome 2 per cent aq'us	+	+	+	+	−	−	+	+	+	+	−	−	+	−	−	−	−	−	+	+	+	−	−	−
Mercurochrome 2 per cent A.A.A	−	−	−	−	−	−	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Metaphen 1:500	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Metaphen 1:2500	+	+	+	−	−	−	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Oxy quinoline sulfate 1 per cent	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Phenol 2 per cent	+	+	−	+	+	−	+	+	+	+	+	+	−	−	−	−	−	−	+	−	−	−	−	−
Liq. hexylresorcinolis S.T. 37	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	+	+	−	−	−	−
Neutral acriflavine 0.1 per cent	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Picric acid 1 per cent	+	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Liquor cresolis comp. 2 per cent	+	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Clymocol	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Clymocol 1:50	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Iodine 7 per cent tincture	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Iodine 3.5 per cent tincture	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Iodine aqueous sol. 5 per cent	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Iodine Davis	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Iodine isotonic sol	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Zonite 1:2	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Zonite 1:4	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Chlorazene	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	−	−	+	+	+	−	−	−

With but one exception (excluding gasoline, benzine, and ether) practically all of the antiseptics investigated are germicidal according to this test, and under the conditions of this test. This fails to coincide with clinical experience.

"A. W." Chart. In the former method the ratio between the broth culture and antiseptic is about 1:19. Furthermore, the organisms are suspended in the antiseptic solution, making This method further includes a freshly inoculated agar slant simulating the recent contamination common to all accidental wounds, and probably all operative incisions.

"A" represents the twenty-four hour growing agar slant culture. "B" is an immediately inoculated agar slant culture; the massive infection and the recent contamination respectively. The figures refer to the time of exposure of the organisms to the antiseptic; plus signifies

positive growth in the transplants after lapse of the afore-mentioned times. The minus sign indicates no growth.

CHART III

AGAR CUP PLATE PENETRATION, USING EQUAL PARTS SERUM AND AGAR.

(Minus indicates no penetration. Figures refer to distance in millimeters of nearest colony to cup rim, which is distance antiseptic penetrated in sufficient concentration to inhibit growth of organisms.)

50 per cent agar blood serum

	S. Aureus	S. Albus	B. Typh
Alcohol, 80 per cent ethyl	—	—	—
Alcohol, 70 per cent ethyl	—	—	—
Alcohol, 60 per cent ethyl	—	—	—
Alcohol, isopropyl	—	—	—
Silver nitrate, 2 per cent	—	—	—
Silver nitrate, 1 per cent	—	—	—
Tincture green soap	—	1	—
Hydrogen peroxide	2	6	4
Mercuric chloride, 1:1000	—	—	—
Merthiolate, solution 1:1000	3	1	3
Merthiolate, tincture 1:1000	9	5	5
Mercurochrome, 2 per cent aqueous	1	2	1
Mercurochrome, 2 per cent alcohol acetone water	1	1	1
Metaphen, 1:500	—	—	—
Metaphen, 1:2500	—	—	—
Oxyquinoline sulphate, 1 per cent solution	8	12	10
Phenol, 2 per cent	—	—	—
Liquor hexylresorcinolis, S.T. 37	—	—	—
Neutral acriflavine, solution 1:1000	2	—	2
Picric acid 1 per cent	—	—	—
Liquor cresolis compound, 2 per cent	—	—	—
Clymocol	1	2	2
Clymocol, 1:50	1	1	1
Iodine, 7 per cent tincture	—	2	—
Iodine, 3.5 per cent tincture	4	4	3
Iodine, 5 per cent aqueous solution	4	4	3
Iodine, Davis	1	2	—
Iodine, isotonic solution	3	4	4
Zonite, 1:2	—	—	—
Zonite, 1:4	—	—	—
Chlorazene	—	—	—

The "F.D.A." method, then, differentiates between the purely non-antiseptic substances and those having bacteriostatic properties, while the "A.W." method indicates the action of the several products in the presence of large numbers of organisms. It is evident from this chart that many substances showing marked antiseptic value when tested by the official "F.D.A." method, fail to inhibit growth of the test organisms or to kill them outright. This is a point of great clinical importance, particularly when it is a common practice to paint large, sloughing, necrotic and purulent areas with an antiseptic solution, for it must be evident that the top layer only of the wound is "disinfected."

Penetration Chart. An antiseptic, to be effective, generally speaking, must be stable in the presence of serum and blood and other organic matter encountered in infected wounds. Otherwise the antiseptic itself is destroyed by chemically reacting with the matter with which it comes in contact, and thereafter possesses no antiseptic properties. Further, it must have penetrability. It must be able to reach the recesses and microscopic sinuses wherein bacteria lurk and develop. To reach these spaces, it must be able to penetrate slough, cellular debris, and serum. This is entirely apart from the penetration of normal healthy tissue and intact epithelium, which is often inferred by the manufacturer and readily assumed by the user, and for which inference the claims are rarely substantiated, and frequently devoid of proof.

This test was devised, then, to determine the penetrating (as afore-mentioned) properties of the several antiseptics herein described. Briefly outlined, this method consists of adding equal parts of previously melted 3 per cent nutrient agar inoculated with a definite quantity of a twenty-four hour broth culture, and sterile serum, in this case beef serum. This mixture is poured into a petri plate. After the gel has hardened, a small disc of the solidified agar is cut from the center of the plate. This resulting cup is the recipient of a measured amount of the antiseptic to be tested. At the expiration of five minutes the antiseptic is blotted from the cup with sterile filter paper, and the inverted plate is incubated for twenty-four hours. In recording final results, which are reported in millimeters, the shortest distance between the cup edge and the nearest colony was interpreted as the distance of penetration of the antiseptic in sufficient concentration to be at least bacteriostatic. The minus sign signifies no evident penetration.

Skin Sterilization Chart. The final method of evaluation of antiseptics in this study is arbitrarily called the skin sterilization method. The technique employed has already been described. This test is of the greatest, and most directly practical, importance to the clinician. The preceding tests have respectively demonstrated that certain substances under ideal circumstances will inhibit bacterial growth; that fewer, in the presence of large numbers of organisms will inhibit growth; that many lack any ability to penetrate serum-agar (in an officially recognized method of procedure). Herewith

are presented the skin sterilization properties of the antiseptics employed in this study. An antiseptic was never used on the same hand twice; nor were similar antiseptics used on the same hand twice.

The figures (1–5) indicate the frequency with which this test was done. Five determinations were done on each antiseptic except where noted. The plus sign indicates growth. The negative sign signifies no growth.

CHART IV

SKIN STERILIZATION.

(Minus indicates no growth or skin sterilization; plus indicates growth, or *no* skin sterilization. Figures refer to number of times test was performed.)

	1	2	3	4	5
Alcohol 80 per cent ethyl	−	+	+	+	+
Alcohol 70 per cent ethyl	−	+	+	+	+
Alcohol 60 per cent ethyl	−	+	+	+	+
Alcohol isopropyl	−	+	+	+	+
Silver nitrate 2 per cent	−	−	−		
Silver nitrate 1 per cent	−	−	−		
Benzine	+	+	+	+	+
Gasoline	+	+	+	+	+
Ether	+	+	+	+	+
Tincture green soap	+	+	+	+	+
Hydrogen peroxide	+	+	+	+	+
Mercuric chloride 0.1 per cent	−	+	+	+	+
Merthiolate 1:1000 solution	−	−	+	+	+
Merthiolate 1:1000 tincture	−	−	−	−	−
Mercurochrome 2 per cent aqueous sol	−	−	−	+	+
Mercurochrome 2 per cent acetone-alcohol-aqua	−	−	−	+	+
Metaphen 1:500	−	−	+	+	+
Metaphen 1:2500	−	+	+	+	+
Oxy-quinoline sulfate 1 per cent sol	−	−	−	−	+
Phenol 2 per cent					
Liq. hexylresorcinolis "S.T. 37"	−	+	+	+	+
Neutral acriflavine 0.1 per cent sol	+	+	+	+	+
Picric acid 1 per cent solution	+	+	+	+	+
Liquor cresolis compound 2 per cent					
Clymocol	−	−	−	+	+
Clymocol 1:50	−	+	+	+	+
Iodine 7 per cent tincture	−	−	−	−	+
Iodine 3.5 per cent tincture	−	+	+	+	+
Iodine aqueous solution 5 per cent	−	+	+	+	+
Iodine (Davis)	−	+	+	+	+
Iodine isotonic solution	−	−	−	−	−
Zonite 1:2	+	+	+	+	+
Zonite 1:4	+	+	+	+	+
Chlorazene	+	+	+	+	+

SUMMARY

As yet there has been devised no laboratory procedure which wholly supplants clinical experience. The in vitro bacteriostatic actions cannot be translated into in vivo terms. A wound, an infection is a dynamic process; the laboratory is largely of a static nature; it can be an indication, not a final opinion. A product failing to demonstrate bacteriostatic properties in vitro, will not find its way into a large clinical experience; and a splendid laboratory record does not guarantee an equally brilliant clinical performance of the antiseptic.

Often the physician who uses the several available antiseptic products is at fault in his application of the preparation. This may be the cause of many of the unfavorable results noted in connection with the use of some of the antiseptics in common usage today. He must first understand the active, dynamic, pathological processes at which his medication is directed. Even with the understanding of the problem at hand, he may and often does do more harm by medication of the wound than all the germs present would do under ordinary circumstances. Through the use of too strong, or too often applied antiseptic he may destroy living and reparative tissues, thereby producing delayed healing on the ulcerated area, an unnecessary slough, or even systemic reactions following the absorption of the toxic products of the tissue degeneration. An agent which kills or inhibits the bacteria present in the wound, but does not at the same time destroy tissue, nor interfere with the natural body defensive mechanism, is far more desirable than one which kills all the organisms present, and at the same time accomplishes the destruction of the tissues with which it comes into contact.

An infection occurs only when the contaminants, present in every wound, are in sufficiently large numbers, or of sufficient virulence to overcome the local defensive processes. Therefore, a mechanical cleansing of the locally contaminated, or later infected area, and the judicious application, probably but once, of a mild antiseptic is sufficient. We do not recom-

mend nor hold any brief for any one antiseptic. Throughout the country, many different skin disinfectants are used in the preoperative preparation, and an even larger number of antiseptics are applied in the treatment of wounds. There are clinical differences between these antiseptics. And yet the morbidity rates are not widely divergent. Which brings us to the realization that whether an infection will develop or not depends largely on the number of organisms present and their relative virulence, the resistance of the host, and least of all on the antiseptic used.

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NEW INSTRUMENTS

A NEW CURVED NEEDLE

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EVERY one is familiar with the antiquated method of "freezing" a pointing abscess which would open merely at the touch of a sharp scalpel. The freezing fluid only causes more pain upon the inflamed tender tissue, which hardens and becomes very resistant to the scalpel. Yet the freezing fluid is still used to "alleviate" pain.

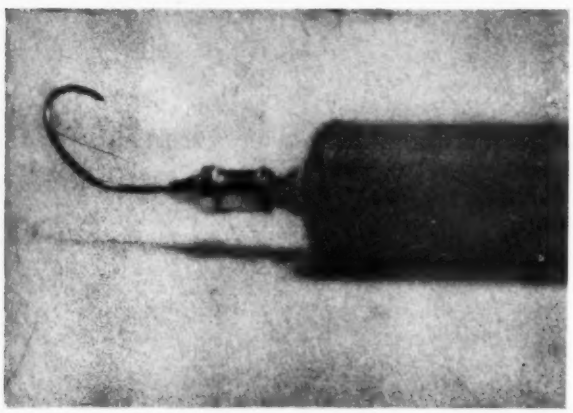

FIG. 1.

In removing small tumors from the skin, either by coagulation or excision, we will carefully surround the growth with some anesthetic fluid, puncturing the skin at various places in doing so, in order to perform a painless operation. True enough, the operation itself is painless, but the preliminary skin punctures are not painless. This is so in removing various growths, such as warts or epitheliomas from the face, where a needle puncture is very painful. To present a method of eliminating such unnecessary pain when removing small tumors from the skin is the object of this paper.

The curved needle illustrated can be used to induce local anesthesia about a small tumor, completely surrounding it with the anesthetic and eliminating the extra needle punctures, thus avoiding unnecessary pain to the patient. The anesthetic fluid is pushed forward while the needle surrounds the tumor, thus making the process practically painless.

The needle could be made in various sizes and diameters, according to the size and location of the tumor. This will not only prevent unnecessary pain to the patient, but will help the surgeon to work in a clean field, diminishing the amount of bleeding from the needle punctures.

The same type needle can be used not only in removing small superficial tumors, such as warts, epitheliomas, lipomas, but it can also be utilized for local anesthesia of the cervix, where the curve of the needle conforms to the shape of the cervix, and for local anesthesia in circumcision, as well as when taking biopsies from superficial lesions.

Though the needle is very simple and differs from the ordinary needle used today for local anesthesia only in its curve, still the good it accomplishes in diminishing pain to the patient and the benefit the surgeon derives from its use make it well worth a trial.

INSTRUMENT FOR INTESTINAL ANASTOMOSIS

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A RAPID closure of the blind end of the intestine may be done in two different ways with this instrument, as well as end-to-end, end-to-side, and side-to-side anastomoses.

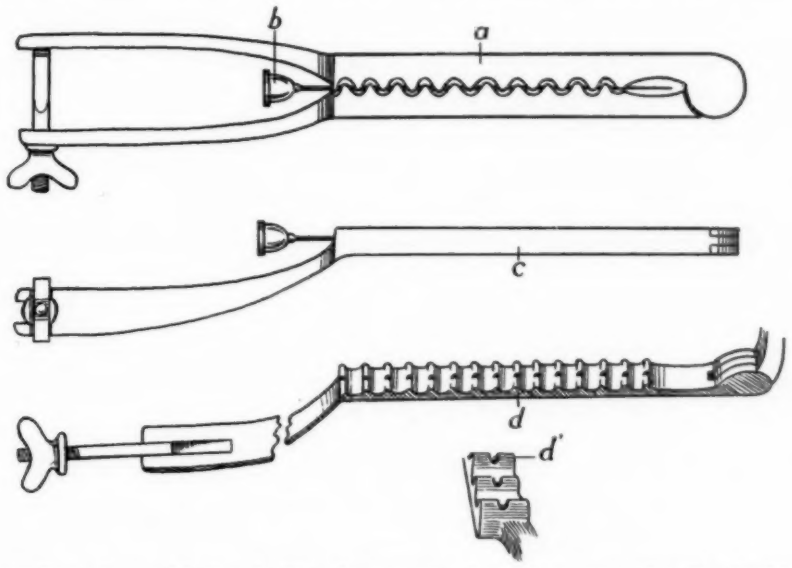

FIG. 1. *a*. Sinuous outline of two blades. *b*. Pin that passes through groove, details of which are shown in *d*. and *d'*. *c*. Profile view.

The inner edge of each blade has a sinuous outline, and the two blades interdigitate when the jaws are approximated (Fig. 1, *a*). On the inner side of each blade is a groove that cuts the teeth two-thirds of their depth (Fig. 1, *d* and *d'*), and in the closed position of the instrument these grooves form a channel through which a needle or pin (Fig. 1, *b*) may be inserted.

To close the blind end of the intestine the gut is clamped and the handle of the instrument locked. The pin is inserted in the groove, piercing the intestine and holding the two walls of the gut together. The distal portion of the gut is removed with the galvanocautery. On releasing the gut from the clamp it will be found that the end has been securely closed on the pin. A guard on the sharp end of the pin prevents injury to the operator. A seromuscular continuous suture is placed so that the serrated edge is inverted, and the pin is removed. A second method of closure is to use a needle with catgut swaged into the eye. This pierces the gut as did the pin: on removal from the clamp, the needle is drawn all the way through and the two ends of the suture tightened and tied. A purse-string suture over this makes a safe closure. (Fig. 2, *i* and *j*.)

Its greatest value will be found in end-to-end and end-to-side approximations.

To secure an end-to-end closure, the two loops of intestine are brought into the jaws of the clamp, the jaws tightened, the pin inserted (Fig. 2, *a*), the distal portions of the gut cut away with the galvanocautery (Fig. 2, *b*), and the instrument removed (Fig. 2, *c*). The two loops of gut (four walls) are thus pinned together. The protector is placed over the sharp end of the pin. A seromuscular suture of chromicized catgut inverts the serrated edge (Fig. 2, *d*) and a continuation of the same suture unites the gut on the opposite side of the pin (Fig. 2, *e*). A few interrupted silk sutures, evenly spaced, insure greater safety. The pin is removed and the lumen of the gut is established by digitally

intussusepting the upper into the lower segment to break up the temporary union of the four walls of the intestine approximating them, applying the clamp, and finishing as in the other methods.

Should the opening in the one gut be made larger than that of the other, it makes no difference as the opening will be with closed by following through the suturing as already described.

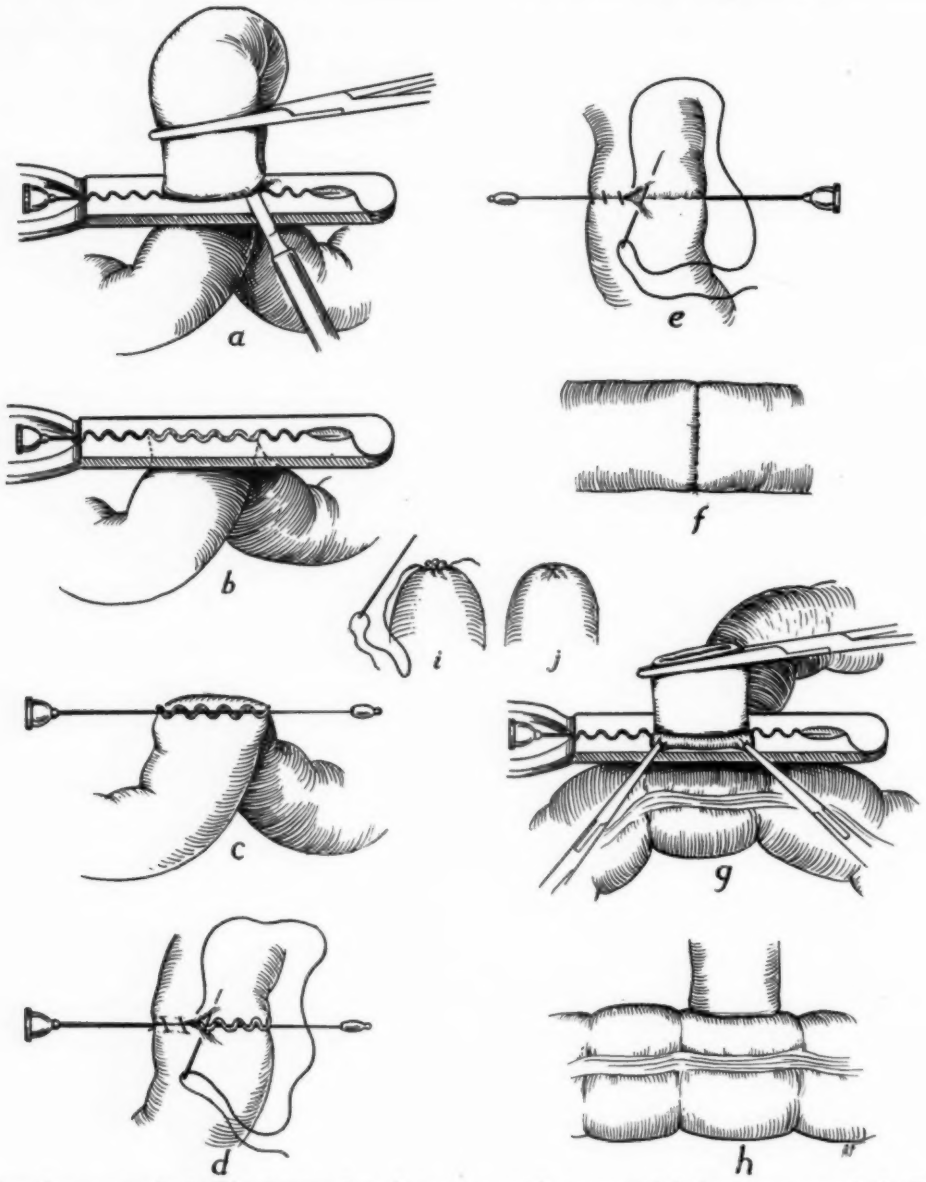

FIG. 2. *a*. Two loops crushed. Pin inserted and portion to be resected being amputated. *b*. Portion to be resected has been removed. *c*. Temporary pinning together of the two intestinal loops. *d*. Suture uniting seromuscular layers and turning in crushed ends. *e*. Continuation of suture on opposite side. *f*. Pin removed, anastomosis completed. *g*. First part of end-to-side union. *h*. Complete end-to-side union. *i*. For closure of blind end of gut a needle and thread is passed instead of pin as in *c*. Two ends when tied close gut. *j*. Purse string inverts suture line.

(Fig. 2, *f*).

The end-to-side closure is accomplished by elevating the walls of the larger gut with Allis' clamps, approximating the smaller to it, engaging all in the forceps, and proceding as before (Fig. 2, *g*). The side-to-side is accomplished by lifting segments of each loop of bowel,

With this instrument ordinarily difficult procedures may be performed quickly, easily, and without intestinal leakage.

The American Journal of Surgery

PUBLISHED MONTHLY BY PAUL B. HOEBER, INC., 76 FIFTH AVENUE, NEW YORK, N. Y.
FOR THE AMERICAN JOURNAL OF SURGERY, INC.

Editor: THURSTON SCOTT WELTON, M.D., F.A.C.S., NEW YORK

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EDITORIAL

PATHOGENESIS OF ACUTE PANCREATITIS

THE pathogenesis of acute pancreatitis has been the subject of controversy for many years. While some authors consider activation of the pancreatic juice as the primary or essential factor in hemorrhagic pancreatitis, others attribute the chief rôle to the fat necrosis; another group considers visceral congestion and intrapancreatic hemorrhages as initial lesions. Divergence of opinions points to the obscurity of genesis of this comparatively infrequent but important lesion. Elucidation of the mechanism responsible for pancreatitis is of great interest for the surgeon as it may offer suggestions for a proper treatment.

The following are the most popular theories concerning pathogenesis of acute pancreatitis:

1. *Infectious Theory.* Although various pathogenic microorganisms have been found in the pancreatic ducts as well as in the glandular tissue in many cases of pancreatitis, they cannot be considered as the responsible agents in every case as the well-known Koch's postulates of specificity such as the presence of germs in every case, cultural isolation of the same type of bacteria in every instance, etc. are not met. Absence of fever and leucocytosis in many patients also speak against the infectious theory. The consensus of opinion seems to be that acute pancreatitis is primarily of chemical rather than of bacterial origin. Probably the appearance of bacteria follows stasis and has no

direct bearing on the acute inflammatory process.

2. *Canalicular or Ascending Theory.* According to this hypothesis, advanced by Hildebrand and d'Opie, a stasis of trypsin in the pancreatic ducts of Wirsung and Santorini leads to digestion of the wall of the ducts by the enzyme; the activated ferment reaches the glandular tissue causing its necrosis. An attack on blood vessels produces more or less abundant hemorrhages, according to the caliber of the eroded vessels; liberated lipase saponifies the contents of necrotic cells and causes fat necrosis.

How does such a stasis of the pancreatic secretion originate? Stones lodged in the ampulla Vateri may cause a stasis of pancreatic secretion but such retention is not sufficient to create pancreatitis; there is abundant clinical evidence to support this statement. Experimental ligation of the main pancreatic duct is followed not by pancreatitis but by a simple atrophy of the exocrine pancreatic tissue. An obstruction of the ampulla may establish direct communication between the common and pancreatic duct, leading to a reflux of bile into the pancreas; the lipase of the bile may participate in the production of fat necrosis. Some authors advanced the theory according to which bile reaching the pancreatic duct produces cellular lesions; resulting disintegration of cells liberates cytokinases which may activate trypsinogen. It has been shown experimentally that an injection of bile into the pancreatic duct during the postprandial period may cause pancreatitis; it is essential that the injection be made at the height of digestion; in other words, congestion is required for successful production of pancreatitis. Clinical observations confirm such findings; it is known that pancreatitis develops usually after a heavy meal.

Certain considerations speak against the importance of stasis in the main pancreatic duct as an agent responsible for genesis of pancreatitis; for instance a cancer of the ampulla Vateri does not produce acute hemorrhagic pancreatitis although it may direct the bile into the duct of Wirsung. Furthermore, gallstones are found more frequently in women than in men while the prevalence of pancreatitis is greater in the male than in the female sex. It follows that the canalicular theory is forced to admit the cooperation of an unknown factor.

Popper expressed an interesting view that activation of pancreatic secretion takes place not in the pancreas but in the biliary tract, as the secretory pressure in the ducts of Wirsung and Santorini exceeds that in the common duct; hence, the pancreatic secretion probably reaches the biliary ducts more frequently than vice versa.

By the process of diffusion the activated pancreatic juice in the distal portion of the common duct, located within the pancreatic gland, may traverse the wall of the common duct and enter the pancreatic glandular tissue. Such activation of the pancreatic secretion in the biliary tract probably takes place only when stasis is created by mechanical or dynamic factors.

3. *The vascular theory* defended by Gilbert is based chiefly on a considerable number of observations of septic or aseptic thromboses of portal or splenic veins in the course of acute hemorrhagic pancreatitis. Sanguinous suffusions and glandular devitalization supply the pancreatic secretion with activated kinases. The pancreatic enzymes become active and produce the characteristic deleterious effects. Controversial opinions may be found in the literature as to the possibility of production of hemorrhagic pancreatitis by a simple ligation of the portal or splenic vein; some experimenters claim that such a simple procedure is unsuccessful unless supplemented by introduction of some poisons. This implies that an unknown factor must play a rôle in addition to the vascular lesions.

4. *Nervous Theory.* Although the main stimulus for pancreatic secretion is secretin

found in the duodenal mucosa, the vegetative nervous system also participates in the stimulation of the gland. The nervous stimulus may be of psychic or chemical nature, e.g. pilocarpine increases the pancreatic secretion. Vascular stasis of vasomotor origin facilitates diapedesis; kinases deriving from blood corpuscles and devitalized glandular tissue may activate the pancreatic ferments; such vascular stasis may be brought about by a congestion after a hot bath, heavy meal, etc. Disturbance of the equilibrium of the vegetative nervous system may also provoke such circulatory disorders. In many instances of hemorrhagic pancreatitis capillary hemorrhages are found also in the liver and kidneys; in other words, according to this hypothesis the pancreatic lesion is only one of the many local manifestations of a pathological constitution. This theory does not replace but rather supplements the vascular theory.

Silvestri, Schweizer and others called attention to certain analogies between essential signs of acute pancreatitis and effects of substances capable of producing disorders of the vegetative equilibrium, namely a vagotonic crisis. After stimulation of the vagus nerve by histamin, cholin, muscarin or arecotin, also after a nitritoid crisis, fall of peripheral blood pressure and congestion of the splanchnic area may be followed by sanguinous suffusions and interstitial hemorrhages within the pancreatic tissue; if the phenomena attain a sufficient intensity, an activation of the pancreatic juice by kinases of the blood or tissue may produce extensive necrotic processes in the gland.

Another observation also seems to speak in favor of the nervous theory: in human beings acute hemorrhagic pancreatitis develops usually during the postprandial period, i.e. at the time when the function of the pancreas is at its height and the organism is flooded with substances which possess vagotonic properties, e.g. histamin or insulin. According to this theory, a passage of a calculus across Oddi's sphincter, thrombosis in the portal system, trauma in the epigastric region, infections and intoxications may indirectly produce acute pancreatitis by causing a shock with a corresponding reaction in the splanchnic area.

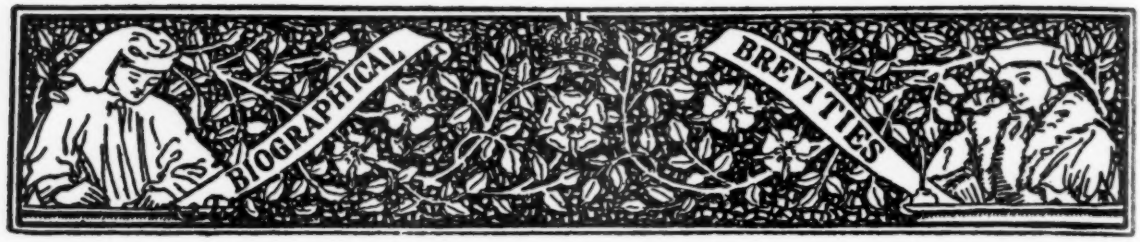
As can be easily seen, this theory brings various causes of acute pancreatitis under one heading; it also offers therapeutic suggestions: as belladonna paralyzes the vagus nerve and adrenalin relieves splanchnic congestion and increases peripheral pressure by stimulating the sympathetic system, and in view of the fact that the vagotonic effect of adrenalin, sometimes noticeable during the first phase of its action, may be prevented by simultaneous administration of belladonna, a combination of both drugs seems to possess therapeutic possibilities and may be given a trial before a surgical interference is decided upon.

From this short recital of the most popular theories of the genesis of acute pancreatitis, the difficulty in reaching a correct conclusion becomes at once apparent. Until further experimental studies shall reveal the underlying causes of the lesion under discussion, the activities of the surgeon must remain confined to the customary procedures preceded in suitable cases by administration of the aforementioned drugs.

Joseph K. Narat

ERRATUM

In the January Biographical Brevities the name of Dr. William Stewart Halsted is incorrectly spelled throughout. We regret this error and take this opportunity to make the correction. The correct spelling of the name is without the "a," that is, Halsted.



JAMES MEASE

BENJAMIN FRANKLIN was mainly responsible for acquiring a "new building" and founding an "Academy" which later became "The Academy and Charitable School of the Province of Pennsylvania," which, in turn, became "The College, Academy, and Charitable School of Philadelphia in the Province of Pennsylvania."

John Morgan graduated with the first class of the College. William Shippen graduated from the College of New Jersey (Princeton). They founded (1765) a medical school connected with the College. Later it took part in forming the medical department of the University of Pennsylvania.

James Mease was born on August 11, 1771 in Philadelphia. In that city he received his early education. At the age of thirteen (1784) he entered the collegiate department of the University of the State of Pennsylvania. In 1787 he received his A.B., and in 1790 his A.M. He began the study of medicine and in 1792 graduated in the first class of what was then the Medical Department of the University of Pennsylvania.

In August, 1790, Mease published a short paper on hydrophobia in the *American Museum*. This brought him some notoriety. He enlarged the subject into his inaugural dissertation under the title, "On the Diseases Produced by the Bite of a Mad Dog or other Rabid Animal." This was dedicated to Benjamin Rush. He wrote his thesis in English (rather than Latin) because of its "being generally useful to my countrymen." Mease's thesis was the first notable contribution on hydrophobia. As a result for many years he was considered the leading authority on the subject. This thesis was republished in London in 1793, with a preface and an appendix by John Coakley Lettsom.

In the *American Recorder* (1819) Mease mentions many cases of hydrophobia that were unsuccessfully treated by bleeding and, again, protested against the use of the "snake stone."

Philadelphia was visited by a yellow fever epidemic in 1793. Mease threw himself into the work of aiding the sufferers. He contracted the disease.

Mease was appointed "Resident Physician of the Health-Office of the Port of Philadelphia" on May 3, 1794.

He was a versatile individual. Many of the intellectual and humanitarian institutions of Philadelphia were supported by him either as a member or an officer. He was a member of the American Philosophical Society, helped in the founding of the Philadelphia Atheneum, was one of the managers of the Company for the Improvement of the Vine, was associated with a group in forming the Philadelphia Mineral Water Association, and was a secretary of the Agricultural Society.

Mease was never on the teaching staff of his Alma Mater, but in 1816 and 1817 he was granted the use of the college building to deliver the inaugural of a course of private lectures on pharmacy. This led eventually to the organization of the Philadelphia College of Pharmacy.

His literary work was extensive.

In July 3, 1800 he was married to Sarah, daughter of Major Pierce Butler, United States senator from South Carolina. By her he had two daughters and three sons.

James Mease died in Philadelphia, May 14, 1846.

T. S. W.

NOTE: A correction pertaining to the January Biographical Brevities appears on page 383.

JAMES MEASE

[1771-1846]

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

BARON DOMINIQUE-JEAN LARREY

NOTES ON THE EGYPTIAN CAMPAIGN*

DONALD E. MCKENNA, M.D., F.A.C.S.

BROOKLYN. N. Y.

I HAVE singled out from among the great group of the late 18th and early 19th century luminaries Baron Larrey, surgeon, soldier, student, scholar, and author, because of his inherent humanitarianism.

His life is exemplary, not alone in its environment of a century ago, but today as well. Filled with the highest ideals, crowded with the romance of wars, stimulated to unscalable heights of valor by the thrill of battle, goaded on by the anguish which suffering humanity provokes, and crowned by an ingenuity born of necessity, Larrey arose from the obscurity of a choir boy in a little village of the French Pyrenees to a world figure whose accomplishments are still brilliant though more than one hundred years have passed since their doing.

Upon the death of his father, Larrey, at the age of thirteen, left a none too comfortable home and journeyed far overland to the city of Toulouse, where his uncle Alexis Larrey had made quite a name for himself as a surgeon. The boy's ambition was already crystallized, and under his uncle's patronage he pursued his studies with avidity, completing them when barely twenty years of age. Then, off he set for Paris, the only city of France in which at that time there were any special opportunities for the study of surgery, and arrived there in the late summer of 1787, one hundred forty-six years ago, with the intention of visiting the various clinics and medical centers. Hardly had he arrived, than the Academy announced a competitive examination for the position of Auxiliary Naval Surgeon. Despite the fact that he had already developed a preference for the army, the prospect of travel which the Naval Commission implied appealed to his youthful ambitions. He was not only successful, but received an appointment as Chief Surgeon of a King's Vessel at the age of twenty-one, a very unusual honor, particularly in view of the fact that he had never been to sea.

His first assignment was the *Vigilante*, a frigate which was to sail on an inspection tour of the French Colonies in America. So, off he started on foot for the Port of Departure, Brest. Upon his arrival he learned that the voyage was postponed until the following Spring, but he immediately applied himself: inspecting the arsenals; observing the construction of

* Read at the November, 1933 Staff Meeting of the Brooklyn Hospital, where some phase of Medical History is a part of each program.

magazines, both aboard ship and ashore; tramping through the shipyards picking up bits of helpful knowledge regarding the unwanton yet resplendant debauchery of the reign of Louis xv; that the black clouds of Revolution hung over France; a

Fig. 1. Baron Dominique-Jean Larrey (1766–1842).

construction, repair, and mechanism of seagoing vessels; into the military prisons; amongst the galley slaves—where did he not go in quest of a desire to familiarize himself with the potential demands which his newly acquired position might impose? This was an early characteristic which became a lifelong habit, and the secret of much of his success—ever seeking, ever learning, ever recording.

Navigation caught his fancy. Hours were spent in its study. All this at twenty-one, when the average young naval officer might well have been thinking of social pleasures, for we must remember that France was barely emerging from the spirit of unrest pervaded the entire nation; venery, drunkenness, licentiousness, and poverty, made of every seaport city a carnal house, ever ready to incarcerate in its gaudy galleries any untainted human that could be drawn into its Stygian labyrinths, all for the sake of a few pieces of gold in return for the lure of its tinselled women.

Larrey either shunned all this or was too preoccupied to even notice it. With the first fair wind of April the *Vigilante* had orders to sail. She actually pulled her mud hook on May 3, 1788, bound for Newfoundland, and four days later Larrey was sea sick. He attempted an analysis of the

ailment, and came to the conclusion that it was the result of mild, but oft repeated, concussions of the brain against the skull due to the pitching and tossing of the vessel. He made the practical observation, favorably affecting his own comfort at least, that repose in a hammock, a bandage about the head, and a light diet afforded the greatest relief. Across the North Atlantic they plowed, sighted Belle Isle, and a shipwrecked group of twenty-three sailors on its barren shore. A landing party, of which Larrey was a member, found the castaways to be starved and nearly frozen to death. Many had already developed gangrene of the extremities. Larrey here learned the caution with which such individuals are re-exposed to warmth, of the value of rubbing the parts with snow water, the gradual approach to the fireside, and the need of vigorous massage to reinstitute the circulation. This he put to good use years later on the retreat from Moscow. When the half-frozen troops crowded the bivouac fires at the end of a march he made them exercise the precautions that the fishermen of Belle Isle taught him, thereby saving many lives and limbs. The survivors aboard ship, he amputated limbs, dressed the wounds, regulated their diet, and brought them safely into port at Newfoundland. The *Vigilante* had been fifty-four days out of Brest.

He had sick among his own crew, for whom he erected cabins on shore and established a hospital, another early tendency which characterized his entire future, for in all of his travels a few days' rest was a sufficient prerequisite for the establishment of a hospital. From the hills round about he collected local herbs and planted a garden near the cabins to insure a ready supply of drugs. Always interested in climate, holding to a theory that certain winds were harbingers of disease, he kept an accurate record of the climatic changes in this corner of the New World. Besides attending to his professional duties he hunted the wild life and stuffed many species of bird and small mammal which he brought back for museum purposes. In the forest he made his first acquaintance with the mosquito. His memoirs do not say, but if he had not been forewarned he was surely forearmed, for upon his advice the men wore gauze veils over their faces and annointed the exposed parts of their bodies with camphorated oil as a satisfactory protection against the pests.

In late October of 1788 the expedition returned to France in unusual good health for such a long voyage, thanks to the efforts of Larrey. His furlough was spent in Paris where the black clouds of the Revolution were gathering. Louis XVI, that vacillating monarch, was without funds. The States General, the Parliament, and the Third Estate were demanding more and more privileges. The King was crying, "What can I do? What's to be done?" Mirabeau was overwhelming the people with his puissant genius and terrible eloquence. These clouds shrouded a tempest which was not slow to burst—July 14th, and what carnage! Such did our naval officer see while a student of Desault at the Hôtel Dieu, later at the Hôtel des Invalides, and then in the Army, which he never forsook.

At this time, at twenty-six years of age, although small of stature he was well proportioned. A well-formed head on broad shoulders; an expressive, mobile countenance, particularly his eyes which were sparkling; the force of the man was expressed by their piercing qualities in moments of animation, and his kindness by their softness in repose; a sympathetic mouth, usually with a smile, perhaps a trifle enigmatic, but always friendly; framed by an abundant crop of black hair which hung in ringlets on his temples and shoulders: add to this a juvenile vivacity, and, as the years pass mellow it by the sedateness incident to his necessary professional dignity; supply to your mind's eye the animation of a military carriage and gait, and you have a portrait of the man.

The abundance of Larrey's hair has become legendary, but an extraordinary fact was that he could not cut it without becoming indisposed. His comment on the phenomenon follows: " . . . Every time I cut my hair, although taking the precaution of leaving it two inches long . . . I do not recover the equilibrium of my health or the perfect integrity of my moral and physical functions until . . . it has grown out to its ordinary length."

1792. He is now a Surgeon Major under Marshall Luckner of the Army of the Rhine. (France always seems to have had an Army of the Rhine.) Percy, the other great army surgeon of this day, was Surgeon-in-Chief to this army. It was he who proposed the neutrality of the wounded, which idea was rejected by General Kray, delaying for seventy-five years this essential humanitarianism, finally effected at Geneva by the Red Cross.

The custom of the army at this time was to place the medical unit one or two miles behind the battle line; to pile up the dead and wounded; and after the battle permit their evacuation to the rear. This caused a twenty-four or thirty-six hour delay in treatment. Many died of shock, hemorrhage, and infection. In the first battle in which Larrey's division was engaged he conceived the idea of "the flying ambulance," and carried it out on a small but successful scale with the Army of the Rhine. It was his first, but probably most lasting, contribution to military surgery. Paris soon heard of it and by the Spring of 1793 he was busily engaged organizing a similar service in the other armies.

Things were happening quickly. France was engaged in military ventures on many sides. An army was stationed in southern France at Toulon, ready to sail to Corsica. Larrey was promoted to the rank of Chief Surgeon of that army and sent thither. He put aside his military duties just long enough to marry Elizabeth Le Roulz de Laville, daughter of the Minister of Finance under Louis XVI, who was to bear him two children, a daughter fair, and a son, who thanks to his parent's tutelage was destined to become more brilliant, although not so famous as his illustrious father.

While awaiting embarkation at Toulon, delayed by a British blockade, he interested himself in hospital work and the subject of submersion. As soon as he heard of such an accident he hastened thither, stripped the patient, applied external heat, tickled the throat with a feather, plugged up one nostril and blew with a bellows into the other, alternately pressing on the thorax and abdomen, gave a warm enema of tobacco juice, bled the jugular vein, and never ceased his efforts for six hours. On many occasions he saved life, and "it was the rapture of a Pygmalion" when he perceived the marble becoming animated under his fingers.

It was here that he first met Bonaparte, then in command of artillery with the Army of Corsica. The general was just beginning to show his revolutionary tendencies. He had recently recovered from a lance wound in his calf inflicted by an English soldier, Napoleon's last wound of the flesh, but not of the heart. Probably neither realized the great warmth of friendship which that chance meeting was to enkindle, nor could Larrey have any visualization of the hardships he would come to endure for this Man of Destiny, his future leader, friend, admirer, and benefactor.

It is of these immediate hardships, and the many to follow, I wish now to acquaint you, for this thrice-wounded surgeon shared the dangers, labors and privations of his troops under all circumstances in the sixty battles and four hundred engagements in which he took part. In the Corsican Campaign the French were in combat with the Spanish troops—ferocious fighters. What carnage followed the capture of a fortress when hidden mines blew up the objective a few minutes after the French had succeeded in occupying it! The dead and dying were strewn about, all but seventy-six had been killed, all horribly burnt by flames, wounded by flying steel, or crushed

by falling stones! There was Larrey working amongst them. One soldier attracted his particular attention: both legs were crushed, his face, hands, and chest burned. A double amputation of the thigh was done, his burns dressed amid all this turmoil, and the patient survived.

The battle continued. The troops passed on to the Spanish second line of defense where catastrophe again overtook them. Their Commander was struck by a shell that passed through his thorax, killing him instantly. That chivalry was not dead is proved by the fact that a twenty-four hour armistice was declared, for purposes of paying tribute to the dead general. On the following day, under the newly appointed commander, the French gained a decisive victory, the Spanish general in turn losing his life in this engagement. Larrey was to see many foes defeated but never again to taste such humiliation until Waterloo. The advent of winter closed this campaign.

His health impaired, he hastened back to Paris for convalescence and reunion with his family. The political situation in the city was grave. Food was scarce, in fact a famine threatened, so the early spring found him back in Toulon, where he spent his time lecturing to young military and naval surgeons on anatomy, augmented by animal experimentation and anatomic dissections.

During the fall and winter of 1797 at thirty years of age he returned to Paris as lecturer at the Military School of Val de Grace, but this assignment was interrupted by a request from the Commander-in-Chief of the army about to invade Italy for his services. This campaign resolved itself into a triumphal march, so that much of his work was in the nature of Sanitary Supervisor. He became acquainted with the goiter districts of the Italian Alps, observed cretins for the first time, and came to the conclusion that "the condition was due to faulty diet, poverty, and the drinking of snow water." In Padua he visited the anatomist Scarpa, who received him with apparent pleasure and presented him with a copy of his treatise on the nerves of the heart. Years later we find Larrey sharing Scarpa's views of the relation of syphilis to aneurysm of the aorta.

In the spring of 1798 began his memorable and lasting contact with Bonaparte, a result of his again being ordered to Toulon where an army was in preparation for a campaign into Egypt and Syria. The campaign was ostensibly to attack English commerce; the underlying political motive to get Napoleon out of France: "He is a dangerous man," said the Directors, "the farther away he is the better."

Bonaparte was making ready for a titanic conflict. Larrey received the appointment of Chief Surgeon and was intrusted with the physical care of thirty thousand troops, having under him one hundred and eight assistant surgeons. In May, four hundred ships set sail from Toulon, two thousand guns crowded on their decks. Bonaparte's aim was to win a colony for France and a reputation for himself. The British fleet under Nelson was scouring the Mediterranean for him. What with bad weather and a naval game of hide and seek, the voyage took four weeks. Upon arriving at last in Egypt Napoleon made known to the Sultan that he venerated the Turks, and was only attacking the Mamelukes, their mutual enemy. The Mameluke's response is an engagement, eight thousand of the finest cavalry in the world, each horseman armed with a sabre made of Damascus steel, and wielded with such force by these impetuous fighters as to frequently accomplish complete decapitation of their foes with one sweep of the weapon. It is not hard to imagine the seriousness of the lesions in those who were wounded. As Napoleon rides along the battle front pointing to the pyramids in the distance he says, "Soldiers, forty centuries are looking down on you." The artillery checks the Mameluke's charge and night brings victory.

The army now pushes out across the desert to Suez. A canal is to be built.

The desert heat is terrific by day, and the sands are strewn with dried bones, remnants of the toll of human life which this relentless stretch of waste had taken. At night the cold is worse than the heat of the day; troops gather up these human remains and try to make a fire, but they give little heat, much odor, and a grewsome appearance.

Skirmishes occur constantly. The Arabs, having no sense of chivalry, kill the wounded as well as the fighting troops. Word is brought back that the advance guard while attempting to take the fortified desert town of El Arich had three hundred wounded. Larrey asked permission of Napoleon to detach himself from the main army for the purpose of assisting them. He rode a dromedary for three days and three nights across the desert wastes to reach them, experiencing the torture of thirst and hunger, but bearing it with fortitude. Arriving late at night he immediately fell to work operating on the wounded. Food was at a premium. He had the horses, such as they were, killed and their flesh served for nourishment. When this was exhausted they butchered the camels. "Horse flesh," says he, "is much superior in quality to camel meat."

The fort finally surrendered, and when Larrey entered he found the court strewn with dead, decomposed, and putrifying bodies. In an underground cavern, hidden away, lying on rotten mats, deprived of light and air, and covered with vermin, he found fifteen wounded Arabs. They all had bubonic plague, some had gangrene, and others malignant fever. Larrey dressed them all.

The Army pushed on to Acra, a heavily fortified town on a peninsula jutting into the Red Sea. It was on a rise of land surrounded by bogs on the land side. Here the troops suffered greatly. The stench from the bogs was frightful, brackish water was the only thing obtainable for drinking purposes, plague invaded the camp, rations were short, and hunger was the lot of all. Larrey shared all these privations with his troops. The siege began. Thirteen different assaults were made before a breach in the wall was effected, and when it was, Larrey took up his station at the breach, dressing the wounded of whom there were two thousand. Without a moment of repose he worked on and on, amputating arms and legs, and even did a trephine operation under what he himself considered a "great natural handicap."

Notwithstanding the deficiency of medical supplies and the poor sanitation of the camp, these wounds passed through their different stages of cicatrization without any remarkable symptoms. During the progress of suppuration the patients were only troubled by worms or larvae of the blue flies, common in Syria. The hatching of the eggs in the dressing caused a disagreeable pruritus. In a footnote in his memoirs he says that, "although they were troublesome they expedited the healing of wounds by shortening the work of nature and causing the slough to fall off." The precise conclusions reached by the late Dr. Baer of Baltimore during the World War, leading up to the maggot treatment of osteomyelitis! All this in 1799. Truly, there is nothing new in treatment.

Their work in Syria done, the Army had to retrace its steps over 60 leagues of desert back to their Egyptian base. This march was depressing beyond description; the troops were fatigued from fighting, poorly clothed, and undernourished from weeks of horse flesh and camel meat diet, washed down with brackish water. Many were ill of bubonic plague. Conjunctivitis was rife. Malignant fever invaded the ranks. Pack animals were at a premium. Napoleon, on this occasion, gave over his own mount for the transportation of the wounded. Into the desert went this army, the weaker being led by their comrades, the stronger bearing the wounded on their shoulders. Facing the hot winds from the South, carrying with it a heat so violent as to make the sun look like a violet-colored disc; the air filled with dust, no water, very little food, and sudden belches of heat,

more intense than can be imagined, produced a suffocation sufficient to bring death to some. The bodies of those who died swelled to prodigious proportions and putrefied rapidly. Larrey experienced all of the agony of this terrible wind (Khamsym), and bereft of all hope fell to the ground in a faint. He does not say how he reached the fertile palm-covered banks of the Nile, but merely comments on the many who never came out of the desert. Reaching the desert's rim, the troops came upon some ponds of muddy water. The soldiers rushed to the edge of these pools and drank with avidity. Hardly had they quaffed before the agony in their throat, stomach, and intestines became unbearable. Larrey was at a loss to explain this phenomenon until some few days later a straggler arriving at the hospital was examined carefully. Upon looking down the patient's throat he discovered the tail of a leech, which with some difficulty he extracted in toto with a forceps. It was later determined that the natives used this quagmire as a breeding place for leeches.

He had opportunity in this country to observe the widespread incidence of ophthalmia, frequently complicated by corneal ulcers, and not infrequently by rupture of the eye ball. Spontaneous cures did occur, but opacities of the cornea and resulting diminution of vision was common. In some instances there was destruction of the tarsal cartilages, and in others the lachrymal glands were destroyed. He believed the principal cause was the violent heat of the day, and the glare of the sun's rays from the desert sand, coupled with the immoderate use of spiritous liquors and venery. He made the further clinical observation that persons of fair complexion were more prone to this affliction, and that the right eye was more frequently involved. He recommended complete rest, excoriation of the conjunctiva, soft bandages, and a composition containing red oxide of mercury. Ulcers of the cornea should not be treated until the conjunctivitis has disappeared.

Tetanus was quite prevalent in upper Egypt, and Larrey, after trying out the usual drugs in vogue, discarded them as valueless. He noted the tendency for the development of this disease in gunshot wounds, and particularly those involving a joint or peripheral nerve. He observed that the function of the brain was not affected, these patients remaining quite lucid until death. His conclusion from this clinical observation was that the peripheral nerves were not elongated cords from the brain substance as was taught by the noted neurologist, Dr. Gall. Larrey advocated opiates, as much as 20 grains at a dose, warm baths, and cooling drinks. He tried cautery to the soles of the feet and along the nerve roots, but this increased the muscular contraction. He, therefore, abandoned generalized cautery and simply cauterized the wound. Early incision was advised, before inflammation took place, and for acute tetanus, amputation of the limb.

In a footnote he states that foreign bodies in the esophagus were common, either fish or chicken bones. He administered dilute mineral acids by means of a tube, so as to protect the teeth. Softening of the bone ensued, and with a probang and curved forceps it was then pushed into the stomach.

Bubonic plague was seriously affecting his troops. He sent out a letter to his assistants regarding its contagiousness. He believed inoculation as practiced by the Egyptians and Turks was useless, and his chief precepts for avoidance of the disease were regular exercise, cleanliness, and good habits.

After attending to his executive duties, including the digestion of reports from his various assistants, he made a trip to the Grand Pyramid, and like many others climbed its sides and engraved his name on the stone that forms its apex. There are undoubtedly but few among the names thereon that merit the distinction to the extent that Larrey's does.

A few days later found him back in the desert accompanying the Army to Alex-

andria on its mission of succor for the inhabitants, who were threatened by an army of twenty thousand Turks encamped on the fortified peninsula of Aboukir. What a sight greeted them on their arrival before the fortress! It was decorated with the heads of forty of their advance guard! Despite this gruesome warning of what might be in store for them, the Army attacked at break of day; the first shock was terrible, but the outcome victory.

Hardly a Turk escaped alive, and those who did were forced to retreat into the river and were drowned. So barbarous were these individuals that Larrey recites the beheading of a surgeon while he was stooped over attending the dressing of some wounded men.

On one occasion during this engagement, while marching with an escort of about two hundred and fifty men, he was surprised by two thousand of the enemy cavalry. Larrey's servant, who was right at his side, had his head cut off. Larrey's comment was that "in this engagement I was exposed to the most imminent danger."

It was at the battle of Aboukir, while Larrey was doing an amputation of a shoulder joint on General Fougières, that he was presented with the famous sword which he ever carried at his side until it was stolen from him in the retreat from Waterloo when he was captured by the Prussians. Napoleon arrived at Aboukir and visited the ambulance just as the operation was being performed. He addressed encouraging words to his general during the painful ordeal, remaining at his side throughout the duration of the procedure. It was hardly ended when the general raised himself on his bloody cot and seizing his sabre, a magnificant sword of Damascus steel, gold mounted, offered it to Napoleon as a token of appreciation from a dying man. "I accept it," said Napoleon, "but only in order to give it in turn to the man who is going to save your life," and turning to Larrey he handed over the sword into the surgeon's keeping, ordering the armourer Berthier to engrave thereon "Aboukir and Napoleon and Larrey."

Among those wounded in the fighting about Cairo was a mameluke of Murad Bey's on whom Larrey did a disarticulation of the shoulder resulting in an uneventful convalescence in the short period of twenty-nine days. Upon the declaration of peace Murad Bey became very friendly with the French, and was so impressed with Larrey's ability that he brought one of his wives and other of his mamelukes for treatment. The Bey one day advised Larrey that he was sending him a remembrance, and shortly thereafter a guardian arrived at Larrey's quarters, and in single file behind him walked twelve veiled women-slaves from the harem of Murad Bey. With solemn greetings the guardian made the presentation, whereupon the twelve veils were raised, displaying to their new master their features which were of rare beauty, each a different type of Caucasian loveliness.

Larrey was overcome with embarrassment. Please remember that he was an unusually moral man, of whom Napoleon said, "He was the most virtuous man I have ever known." Throughout his career he had lived an exemplary life, and seemed devoid of the passions so much a part of the military men of his time. Furthermore, he was devoted to his wife, thought of her constantly, and wrote almost daily. If Larrey refused this gracious gift on the part of Bey he would incur great displeasure from this ruler—so accept them he did, and undoubtedly became quite a favorite among his fellow officers, as he placed the harem at their disposal. All would have been well had not Madame Larrey gotten wind of this affair, and woman-like, drew her own conclusions, which were not complimentary to Larrey. Her letters, which at best were very rare, ceased entirely. After waiting long enough to be assured of her indignation, he got his dander up, so to speak, and wrote her a letter explaining just how he acquired the twelve beautiful women, and just why he

had to keep them, adding a thought that he didn't need a harem to have "fallen by the wayside," but, said he, "your image is much more beautiful to me"; thus explained the honest Larrey.

Josephine had bought a fine estate near Paris, and a junior officer whom Napoleon had cashiered home was living with her. Nelson had destroyed all but four ships of Napoleon's fleet, but Napoleon risked a sea trip through the British blockade, and left General Kleber in command in Egypt. Kleber, shortly afterward, was assassinated at Alexandria by a fanatical young Philistine. This greatly unnerved Larrey, who bore a deep affection for Kleber. The culprit was court-martialled, found guilty, and received the punishment that was usual for such crimes.

Larrey witnessed the torture that the culprit bore with fortitude and composure for four hours. It included the burning off of his right hand and subsequent impalement. The stake with which he was impaled fractured his sacrum, lacerated the abdominal viscera, penetrated the vertebrae, and imbedded itself in the spinal cord. He survived for about four hours in the greatest torment, without uttering a groan.

Larrey encountered a great many injuries of the skull and brain during the Egyptian Campaign, and concluded that it was proper and necessary to search for foreign bodies within the cranium, providing it be done with care and dexterity. One case report will illustrate this point. A soldier received a gunshot wound of the frontal bone, which passed through the inner table, entered the cranium between the bony vault and the dura mater, and travelled along the longitudinal sinus to the occipital suture where it stopped. Symptoms of compression followed. Localization was difficult. A sound was introduced, the musket ball identified by its resistance and irregularity, and the distance from the surface to the foreign body measured. The occipital region was trephined with a discharge of a quantity of pus, and the extraction of the ball, which was extradural.

He was successful in doing a disarticulation of the hip joint. This had been performed a few times before for a chronic inflammation of the bone, but never for gunshot wounds.

He encountered leprosy among his troops, the result of their having slept upon the mattresses of natives who had the disease. Egyptians at this time were well informed on the contagiousness of this disease, and excluded the leper from society. This custom dated back to the early Egyptian culture, a contribution of the clinical observations of ancient Jewish and Arabian physicians. The only measures Larrey proposed were isolation of patients and cauterization of the lesion.

And now we come to his declining years, with the normal urge for the renewal of contact with the personages and places that had meant so much to him in his earlier life. His friends in Paris were largely made up of the remnants of the Napoleonic aristocracy: Generals, Officers of the Guard, Grand Dames of the bureaucracy, coming to the grand old man with their various complaints, and putting their lives in his hands as their final illness approached, one with cancer of the tongue, another with stone on the kidney, another with cerebral arteriosclerosis. They were rich in pomp and poor, very poor, in circumstance. No fees were gathered from these labors, occasionally a memento. Of one he wrote, "The General is burning up with gratitude, but all I saw was a sparkle, he gave me a very small diamond."

Sir Walter Scott visited him. Lord Egerton, one of the greatest Greek students of the age, dined with him, bringing his dogs, and Larrey, catering to a whim of his Lordship, provided a place at the table for the dogs. Egerton's intelligence was of the highest order, and his morality of the lowest. The brandy must have been good, for Egerton's parting request was that Larrey embalm him.

Laetizia Bonaparte was still alive, so off to Italy he went, accompanied by his son. The old lady was over eighty years

old, but still as keen a mentality as ever. There she lay on a tiny bed in a dreary room, withered and physically spent. She recognized him at the sound of his voice, a gentle embrace was followed by a long conversation, quite an unusual thing for Laetizia. They talked politics. At the termination of the visit she thanked him in touching words of appreciation and presented him with a gold snuff box and a cameo of Napoleon's bust. Hippolyte was so impressed with the strong bonds of friendship between the Bonapartes and his father that he later wrote a book concerning the life of Laetizia.

In March of 1842, accompanied by his son, Hippolyte, he revisited Egypt, where the memory of his greatness was still fresh in the minds of the Army veterans, many of whom had become officers of high rank. Friendships were rekindled and celebrations arranged in his honor. Escorts of crack regiments accompanied him from place to place.

Under the magnetic spell of the desert his spirit seemed to fly back to the delightful exploits of his earlier years. The scenes were so similar that they almost made the illusion complete—here were soldiers, garrisons, the frequent skirmishes with the desert tribes, the flying ambulances in operation, even a mameluke on whom he had operated greeted him. It was too good to be true. A premonition was born of such ecstacy that his earthly time was shortly drawing to a close.

Gathering together one beautiful spring afternoon some forty of the younger officers, he held them spellbound with his recitations of some of the more heroic episodes of battle that he had witnessed. One officer remarked to another, "Oh, the glory of those days," whereupon Larrey, overhearing the remark, admonished them and pointed out the seriousness of war, its cruelties and wastefulness of useful lives, and reminded the audience of the probable toll war would take of their own little group; his words proved quite true, some ten of them were eventually killed upon the field of battle.

On a tour of inspection of the prisons he quickly sensed the cruelty, humiliation, injustice, and severity of the punishments meted out to soldiers for infraction of army regulations. The presence in crowded, ill-kept, poorly ventilated dungeons of men with valiant hearts and courageous souls caused him to plead with their officers for a more charitable attitude towards them; pointing out that from long contact with human nature he knew that there were sparks of goodness and even flames of greatness smoldering within them, and that unwanton punishment only thwarted the object to be attained by causing resentment.

The joys and emotions of the visit were quickly telling on the old man's vitality. He became appreciably more feeble and emotional. He had seen all there was to see, and on July 5th embarked for home, a destination that he never reached, dying at Lyons en route on July 25, 1842; his son received on the same day a message from Paris announcing the death of the Baroness, his mother, only the day before.

Larrey's body was borne through the streets of Paris to its final resting place in the Cemetery of Pere-La-Chaise in the town of Val de Grace, now a part of the City of Paris. In mournful cadence marched the great and the near-great. The occasion was one of solemnity and pageantry, the press, the public, the medical profession, the military, and the government, all joining in a demonstration of their extreme sorrow for his passing.

As he had carved his initials on the Pyramid, so France has inscribed them on the Arche de Triomphe. As Da Costa said of him, "Those of us who go to Paris and look at the tomb of Baron Larrey can feel with justice that there is buried a soldier, a patriot, a great, learned, and brilliant surgeon; a brave, truthful, and loyal man; a gentleman, and a benefactor of the human race."

BOOK REVIEWS

Benign Tumors in the Third Ventricle of the Brain: Diagnosis and Treatment. By Walter E. Dandy, M.D. Springfield, Ill., Charles C. Thomas, 1933.

This is a monograph of the highest type, covering a small field with almost German "Gründlichkeit." The illustrations are numerous, well selected and beautifully reproduced. The case reports are splendidly documented.

The author stresses an optimistic note when he says: "A most interesting and important group of tumors lying within the third ventricle has, until the past few years, remained without the fields of diagnosis and treatment. Of benign type, slow growth and small size, their removal by surgical treatment is relatively simple and affords a permanent cure if only a correct diagnosis and localization can be made."

Surgeons doing brain surgery will find this book essential. Others through its study will perhaps learn to make diagnoses in time to do something for the patient.

Wilhelm Conrad Röntgen and the Early History of the Roentgen Rays. By Otto Glasser, with a Chapter "Personal Reminiscences of W. C. Röntgen" by Margret Boveri. Springfield, Ill., Charles C. Thomas, 1934.

This is a translation of the book published several years ago by the author in German. It is fortunate indeed to have the early history of the roentgen rays written while many of the pioneers are still alive.

Interesting details are given regarding the life and personality of the discoverer of the *x*-ray. Of particular value are the chapters giving the history of the science of roentgenology, and an inkling of the task involved is indicated by the bibliography of books and pamphlets on roentgen rays published during 1896. There are no less than 1044 items listed as published during the first year after the discovery. The inclusion of a chapter on "Röntgen's Discovery in Contemporary Humour" is an evidence of the thoroughness with which the subject is covered. The illustrations of the earliest apparatus and the story of what was accomplished with it will be of particular interest to the younger roentgenologists.

The book is not only meaty and authoritative but is interestingly written and should find a place in the library not only of every roentgenologist but of every physician interested in the progress of medicine.

The fact that in 1896 "H. D. Hawks of Columbia University gave roentgenological demonstrations in Bloomingdale's great department store in New York" is perhaps as good an illustration as any of the rise of roentgenology as a science, since that time. The standing of roentgenology and roentgenologists today after a span of less than forty years marks a thrilling era in the history of medicine parallelling, with truly modern speed, the rise of surgery from the era of the barber surgeons. We bespeak for this book the great success that it deserves.

De Venarum Ostiolis 1603 of Hieronymus Fabricius of Aquapendente (1533?–1619). Facsimile Edition with Introduction, Translation, and Notes. By K. J. Franklin, D. M. Springfield, Ill., Charles C. Thomas, 1933.

This work of Fabricius, so important to Harvey in the research that led to his discovery of the circulation, has never before been translated into English. Dr. Franklin of Oxford is to be congratulated on doing this work, and to the Carnegie Corporation much credit is due for the grant which rendered its publication possible.

The volume includes a facsimile of the original text together with a translation and reproductions of the illustrations.

This book makes a worthy companion to the various translations of "De Motu Cordis" and will be of great value to students of medical history.

Medicine in Virginia in the Nineteenth Century. By Wyndham B. Blanton, M.D. Richmond, Garrett & Massie, Inc., 1933.

This is the third volume of a trilogy published under the auspices of the Medical Society of

Virginia. Covering as it does the 19th century, this volume will probably be the most interesting to many men. Not only is the medical work in Virginia taken up but one of the chapters entitled "Contributions to the Medical Annals of Other States" is of particular interest, telling, as it does, of the Virginia-born medical men who went to other states and made distinct contributions to the advance of medical science. The number of such men is rather startling. It adds a human and practical as well as rather unusual touch to a history of this kind.

Of interest also is the chapter covering the Civil War, in which the history of the activities of the Confederate Medical Corps around Richmond is well told.

Dr. Blanton is to be congratulated upon the completion of a work which is a real contribution to Medical Americana. It is the type of work that would have pleased Sir William Osler and may well be accepted as a model for others to follow. The binding of the book in canvass stamped with Indian emblems is especially interesting and the typography leaves nothing to be desired.

MENTAL HYGIENE IN THE COMMUNITY. By Clara Bassett. N. Y., The Macmillan Company, 1934.

There has been need for just such an exposition on mental hygiene as is presented in this work. In 12 chapters, the book covers authoritatively and concisely all the various phases of this all important division of both medicine and public health work.

The physician and surgeon, no matter what his specialty, will benefit by reading this book and will find it a valuable work to have at hand for reference.

PHYSICAL TREATMENT BY MOVEMENT, MANIPULATION AND MASSAGE. Third Edition of Massage, Its Principles and Practice. By James B. Mennell, M.D. Phila., P. Blakiston's Son & Co., 1934.

It is interesting to note the author's comment in the Preface that "The former title of this book, 'Massage! Its Principles and Practice,' seems now to be so out of date that, with my publishers' permission, I have decided to change it." It seems unfortunate that so valuable a medical treatment as massage should have fallen into such disrepute as to require an alias. This edition of Dr. Mennell's book, like his former ones, is plainly written and full of common sense. It will be found valuable not only by those wishing to study the technique of massage but also by surgeons wishing to know the indications for its application.

DIAGNOSTICS URGENTS: ABDOMEN. By H. Mondor, M.D. Ed. 2, Paris, Masson et Cie, 1933.

The call for a second edition of a two-volume work on Urgent Diagnosis in Abdominal Diseases is perhaps the best comment that could be made on its value. That we have found it a worthy compendium to Lejars' "Urgent Surgery" expresses as well as a long review could the estimate that the reviewer places upon it. To every surgeon reading French, we heartily recommend this work which, in addition to being well written, is splendidly illustrated, comprehensive and authoritative.

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